Chapter 4: Environmental Consequences

Introduction

This chapter provides detailed discussion of the probable environmental consequences, or impacts, of implementing each of the five alternatives. The chapter begins with an explanation of how the impact topics were chosen, which impacts were dismissed from consideration and why. Terms used to define impact levels are defined. This is followed by a discussion of methods used to conduct the analyses and a description of the methods used to assess impacts for each impact topic (e.g., soils, visitor experience, etc.), including relevant policies, regulations, and assumptions. Individual analysis of the impacts related to each alternative (A, B, C, D, and E) include:

- identification of impacts associated with the various actions comprising the alternative;
- characterization of impacts, including their duration and intensity;
- available mitigation measures and the effectiveness of these measures on reducing impacts;
- assessment of cumulative impacts; and
- a summary of the impacts and an assessment of the potential for an alternative to impair resources (based on the NPS definition of and policy on impairment).

Impact Topics and Their Derivation

Resources for analysis were selected primarily because the actions in the alternatives have the potential to affect them, both in adverse and beneficial fashion. The impact topic is a very short summary (see Chapter 1) of the relationship between an action in a given alternative (capturing deer to treat them with a contraceptive, for example) and a resource (water, air, etc.). Although impact topics are initially presented in the first chapter, the extent of damage or benefit from this relationship is analyzed in this chapter. Seashore staff develops impact topics, but laws, regulations, and policies may require discussion in an impact topic, and/or the public may have raised topics during scoping. Impacts to the following resources are addressed for each of the five alternatives:

- Water Resources and Water Quality
- Soils
- Vegetation
- Wildlife
- Species and Habitats of Management Concern (e.g., threatened, endangered, rare or sensitive species)
- Human Health and Safety
- Visitor Experience
- Park Operations
- Regional Economy

All of these topics, with the exception of Human Health and Safety, were raised during public scoping from May 4, 2002 to July 5, 2002. For details about public concerns, see Chapter 5.

Definition of Terms

The environmental analysis in this chapter includes the direct, indirect, and cumulative effects of the alternative actions on the environment.

Direct impacts - occur as a result of the alternative in the same place and at the same time as the action.

Indirect impacts - are reasonably foreseeable impacts that occur in a time or space removed from the proposed actions. These are "downstream" impacts, future impacts, or the impacts of reasonably expected connected actions.

Cumulative impacts - are actions that, when viewed with other actions in the past, the present, or the reasonably foreseeable future, regardless of who has undertaken or would undertake them, have an additive impact on the resource this project would affect.

Impacts are described in three ways for each alternative: by impact type, impact duration, and impact intensity. For purposes of this analysis, these impact characteristics are defined as follows:

Type of impact - describes the specific elements that could be subject to impacts and the nature of those impacts. Impacts can be either beneficial or adverse.

Duration of impact - describes the relative length of time the impact would affect a given resource. Impacts can be either short-term or long-term, and are defined for some impact topics by a range of years. It is important to note that an action that has short-term adverse impacts on a resource may have long-term beneficial impacts on the same resource.

Intensity of impact - The intensity of impact provides a way to assess the relative importance of the impact. Each impact is described as negligible, minor, moderate, or major. These four qualitative designations are used for beneficial as well as adverse impacts.

Resource impairment - At the end of each impact topic assessment is a statement regarding whether or not implementing the alternative would cause resource impairment. The NPS Organic Act of 1916 and the NPS General Authorities Act 1970, as amended, require park managers to ensure that park resources and park values remain unimpaired. The term "impairment," although usually defined in common usage as a worsening or diminishment in ability, value, or excellence, has specific definitions when used in an NPS Environmental Impact Statement. Section 1.4.5 of the NPS *Management Policies* 2001 states: "The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values." The NPS *Management Policies* 2001 further state:

> "An impact to any park resource or value may constitute an impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:
>
> - Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
> - Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
> - Identified as a goal in the park's general management plan or other relevant NPS planning documents.
>
> An impact would be less likely to constitute an impairment to the extent that it is an unavoidable result, which cannot reasonably be further mitigated, of an action necessary to preserve or restore the integrity of park resources or values."

Regulations, Policies and Methodology

The sources of information, assumptions, and application of information in the analysis of each affected resource is described in the Assessment Methodology sections below. These sections also define intensity thresholds and duration. A summary of relevant laws, policies, and regulations is also included.

Water Resources and Water Quality

The water resources within the project area include a substantial number of perennial and intermittent streams, human-made impoundments, wetlands, natural lakes and sag ponds. They support a variety of threatened and endangered species including coho and Chinook salmon, steelhead trout, California freshwater shrimp, and California red-legged frog. Watershed storage capacity and water quality can be impacted by soil erosion and compaction caused by non-native deer and their management. Off road vehicles and stream or pond usage by large concentrations of deer can cause altered drainage patterns, degraded water quality, and increased sedimentation.

Policies and Regulations

The Clean Water Act (33 U.S.C. 1251 – 1376) requires the NPS to "comply with all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution." The NPS Freshwater Resource Management Guidelines (found in NPS-77) requires the NPS to "maintain, rehabilitate, and perpetuate the inherent integrity of water resources and aquatic ecosystems."

NPS *Management Policies* 2001 state: "The Service will manage watersheds as complete hydrologic systems, and will minimize human disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams. These processes include runoff, erosion, and disturbance to vegetation and soil caused by fire, insects, meteorological events, and mass movements…The Service will achieve the protection of watershed and stream features primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded."

Assessment Methodology

The following three primary aspects of water resources were assessed when considering potential impacts:

- hydrology of the project area
- aquatic habitat within the project area
- water quality

Hydrology refers to hydrologic processes such as flooding, erosion, deposition, and maintenance of channel patterns. Aquatic habitat refers to the attributes that support or provide habitat within stream or pond systems. Water quality refers to the suitability of surface water for beneficial use, including cold-water or warm-water aquatic wildlife habitat and recreational use. Relative to water quality, Tomales Bay and Lagunitas Creek have been listed as impaired (impaired has a different meaning in the National Park Service) by the San Francisco Regional Water Quality Control Board for sediment, nutrients and pathogens. Particular consideration was given to actions with potential to affect the natural hydrology, aquatic habitat features, and surface water quality of cold-water streams. Specific watersheds supporting cold-water aquatic habitat include Lagunitas Creek, Olema Creek, Pine Gulch Creek, and most coastal drainages originating from Inverness Ridge. Also of concern are pond features that are considered breeding habitat for the California red-legged frog. Ponds are located throughout the project area.

Generalized information from the literature regarding the types of effects and their magnitude to water quality and streamflow characteristics from ungulate grazing were used to estimate impacts to park water quality or hydrology from non-native deer. Observational information from park staff on the impacts of non-native deer congregating near streams was also used. Data on the presence or absence of species sensitive to sedimentation in Seashore streams was integrated into the analysis to show where particular concerns to water quality or aquatic habitat from grazing by non-native deer are likely.

Type of Impact

Adverse: would alter natural hydrologic conditions (e.g., impede flood flows, cause unnatural erosion or deposition, etc.), degrade water quality (e.g., increase pollution or bacteria levels from recreational use), or degrade aquatic habitat.

Beneficial: would restore natural hydrologic conditions (e.g., remove impediments to flood flows, stabilize riverbanks, etc.), improve water quality (e.g., reduce non-point source pollution), or improve or maintain aquatic habitat

Duration of Impact

Short-term: would last two years or less.

Long-term: would last longer than two years.

Note: Since full implementation of an alternative would take place over a number of years, this section considers the duration of individual actions within each alternative (e.g., control of non-native deer by lethal means or reproductive control) as well as full implementation of the alternative (e.g., removal of all non-native deer from the Seashore).

Intensity of Impact

Negligible: would be imperceptible or not detectable.

Minor: would be slightly perceptible, without the potential to expand if left alone; and would be localized (i.e., would occur in the immediate vicinity of an action).

Moderate: would be apparent locally and would have the potential to become larger or regional.

Major: would be substantial, highly noticeable, and regional (i.e., would occur over a large area, such as the Tomales Bay watershed, or Point Reyes National Seashore).

Soils

Soils might be affected through direct disturbance, mechanical compaction, and indirectly through reduction of overlying vegetation.

Policies and Regulations

NPS *Management Policies* 2001 state: “The Service will actively seek to understand and preserve the soil resources of parks, and to prevent, to the extent possible, the unnatural erosion, physical removal, or

contamination of the soil…." In addition, NPS-77 (Natural Resource Management Guidelines) lists the following objectives for the protection of soils within different management zones:

Natural zone: preserve natural soils and the processes of soil genesis in a condition undisturbed by humans.

Cultural zone: conserve soil resources to the extent possible consistent with maintenance of the historic or cultural scene and prevent soil erosion wherever possible.

Development zone: ensure that developments and their management are consistent with soil limitations and soil conservation practices.

Special use zone: minimize soil loss and disturbance caused by special use activities, and ensure that soils retain their productivity and potential for reclamation.

In addition, soils that are identified as "hydric," which often are a feature of wetlands, are protected by policies such as Director's Order 77-1, Wetland Protection. Hydric soils usually form under wet conditions sufficient to develop anaerobic conditions and support hydrophytic vegetation.

Assessment Methodology

The methodology for assessing impacts to soils was to use scientific literature and information about soils in the Seashore that might be affected by non-native deer. Information on the specific impact of fallow deer on soils in the Seashore has recently become available (Fellers and Osbourn 2006). In addition, information on impacts of other species of deer or ungulates on soils was used. Soil types and characteristics of soil in the area of the Seashore occupied by fallow and axis deer was information folded into the analysis to determine broadly where erosion or compaction might be more likely.

Type of Impact

Beneficial: would protect or restore chemical, physical, abiotic, or biotic soil components.

Adverse: would result in degradation of chemical, physical, abiotic, or biotic soil components.

Duration of Impact

Short-term: could be restored when project activities are completed and would last 10 years or less.

Long-term: would last more than 10 years.

Intensity of Impact

Negligible: would be imperceptible or not detectable.
Minor: would occur on less than 100 acres of ground.

Moderate: would occur on 100-500 acres of ground.

Major: would occur on more than 500 acres of ground.

Vegetation

Non-native deer management can directly impact vegetation; as a result of trampling, grazing, or browsing by deer or as a result of human or vehicular trampling in large-scale deer capture or culling operations. Deer can also cause indirect effects, such as competition between plant species, dispersion of weeds via deer gastrointestinal tracts, and changes in grazing pressure that might alter vegetative landscapes. Recent research indicates that exotic herbivores facilitate the abundance and species richness of non-native plants while native herbivores provide biotic resistance to invasion by non-native plants (Parker et al. 2006). Indirect impacts from capture or culling operations would also include increased potential for the dispersal of non-native plant seed and vegetative propagules.

Policies and Regulations

NPS *Management Policies* 2001 (Section 4.4.1) state: "The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The policies go on to state that the above statement includes flowering plants, ferns, mosses, lichens, algae, fungi, and microscopic plants. The NPS is mandated to preserve and restore the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of these native species. In addition, the NPS is mandated to prevent the introduction of exotic (non-native) species into units of the national park system. The policy manual NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on vegetation management.

Assessment Methodology

Vegetation in the park was digitally mapped using aerial photographs in 1999/2000 as part of the development of a park-wide vegetation map. Field data on plant species composition were subsequently collected to characterize and classify the plant communities delineated in this mapping effort. The classification describes the vegetation alliances and associations found in the park (including all acreage delineated as non-native deer range), and are based on the classification system under National Vegetation Classification Standards. For purposes of this document, alliances and associations found in the study area have been grouped together into 10 broad vegetation classes that are described in Chapter 2.

Vegetation communities utilized by axis and fallow deer were calculated using the park vegetation map Geographic Information System (GIS) coverage in combination with the most recent non-native deer range maps. The current range maps were developed using non-native deer sightings from 2000 to the present. By overlaying each coverage, each vegetation community could be quantified by acreage. Again, this does not provide any temporal information specific to how intensely each community is used, only the types of communities where non-native deer have been observed.

In addition, in a study conducted by Humboldt State University since 2000, analysis of deer fecal pellets allowed description and comparison of tule elk and fallow deer diets in the Limantour area of the Seashore. Description of the vegetation types used as forage by these species, as well as information obtained in the literature, allowed a determination of impacts to vegetation.

Beyond this site-specific information, the literature was consulted for information generally about the impacts of deer on vegetation communities.

The following parameters were used in the evaluation of impacts on vegetation:

- the vegetation class that would be affected (e.g., Bishop pine forest);
- the abundance or rarity of the vegetation class in the study area and in the region; and
- the presence, abundance, and species richness of non-native plants within, or adjacent to the vegetation classes affected.

The abundance, or areal extent, of the vegetation class is important when considering project impacts because the Seashore is mandated to protect and maintain all native plant communities. If a vegetation class is very rare in the project area or the region, such as riparian woodland, adverse impacts to the vegetation class become more intensive.

Type, duration, and intensity of vegetation impacts are described as follows:

Type of Impact

Beneficial: would increase the size, continuity, or native species richness of a plant community, or would decrease invasive non-native plant species abundance or richness.

Adverse: would decrease the size, continuity, or native species richness of a plant community, or would increase invasive non-native plant species abundance or richness.

Duration of Impact

Short-term: would be measurable for less than two years; plant composition, productivity, and reproduction would change initially, then return to pre-project conditions.

Long-term: would be detectable for longer than two years; plant composition, productivity, and reproduction would change and these changes would persist post-project.

Intensity of Impact

Negligible: would result in no measurable or perceptible changes in plant community size, continuity, or native or non-native species richness.

Minor: would be measurable or perceptible but would be localized within a relatively small area; the overall viability of the plant community would not be affected.

Moderate: would cause a measurable and perceptible change in the plant community (e.g., size, continuity, or native or non-native species richness), but the impact would remain localized and the change could be reversed.

Major: would be substantial, highly noticeable, and could irreversibly change (i.e., be permanent) plant community size, continuity, or species richness.

Wildlife

Wildlife can be impacted in a number of ways by non-native deer management. Directly, wild animals can be injured or killed during deer capture, monitoring or management operations. Indirectly, through destruction of habitat and competition for required resources, animals can be impacted by changes in the abundance and range of non-native deer.

Policies and Regulations

NPS *Management Policies* 2001 state: "The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The policy statement includes bacteria, mammals, birds, reptiles, amphibians, fishes, arthropods, worms, and microscopic animals. The NPS is to preserve and restore the natural abundance, diversities, dynamics, distributions, habitats, and behaviors of these native species. Maintaining of genetic diversity "to increase the variability of the park gene pool" is required. In addition, the NPS is mandated to prevent the introduction of exotic (non-native) species into units of the national park system.

The policy manual NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on wildlife management. Management should strive to perpetuate natural ecosystems through maintaining or restoring natural processes to the extent practically feasible. Specifically, "maintaining, restoring, or simulating natural processes is a more realistic goal than is the pursuit of a hypothetical static situation that is unachievable and may even be undesirable."

The NPS also is required to comply with the Fish and Wildlife Coordination Act; the Marine Mammal Protection Act; the Bald and Golden Eagles Protection Act; the Wilderness Act; the Convention on International Trade in Endangered Species; and maritime and other international agreements. The NPS also is required to comply with The Migratory Bird Treaty Act (1918), which prohibits taking, killing or possessing migratory birds, nests or eggs. And, as a refuge for tule elk, Point Reyes National Seashore is directed to participate in a Federal/State cooperative program for preservation and enhancement of tule elk in California under the Tule Elk Preservation Act (1976, 16 U.S.C. 673d). The Act requires the Secretary of the Interior to "cooperate with the State of California in making lands under (his/her jurisdiction) reasonably available for the preservation and grazing of tule elk in such manner and to such extent as may be consistent with Federal Law."

Assessment Methodology

Impacts on wildlife, within Point Reyes National Seashore have been assessed in terms of the following:

- changes to wildlife habitat, including food source, water source and cover or nesting habitat;
- changes in the number of wildlife species (species richness);
- changes in the number of individuals in a wildlife species;
- changes in the productivity or growth of a species;
- changes in the range of a species; and
- changes in the genetic variability within a population or sub-population.

Some information specific to this analysis has been collected for wildlife at the Seashore; for example, dietary overlap information for non-native deer and black-tailed deer is available. However, the literature was consulted for information about the effects of fallow and axis deer on wildlife and wildlife habitat when site-specific data were not available.

Type of Impact

Adverse: would result in unnatural changes in survival or reproduction, viability of a population or species, unnatural distribution of available resources or habitat.

Beneficial: would result in protection or restoration of viability of a population or species, or natural distribution of available resources or habitat.

Duration of Impact

Long-term: would last two years or longer. This represents two breeding cycles for native wild ungulates, many bird species and most medium and large carnivores in the Seashore, all of which would be considered in the impact discussion. Two years represents at least two breeding cycles for most small mammals, amphibians and reptiles, which would be considered in the impact discussion. An impacts to more than two breeding cycles is considered long-term.

Short-term: would be expected to last for less than two years or two breeding cycles. See rationale for the two-year definition above.

Intensity of Impact

Negligible: would not be measurable or perceptible.

Minor: would be measurable or perceptible and would be localized within a relatively small area or portion of the species range within the Seashore. The overall viability of the resource or population would not be affected. After the initial occurrence, the adverse effects would be fully reversible.

Moderate: would be sufficient to cause a change in the resource or population (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized in the Seashore. The change would be measurable, but negative effects could be reversed with active management, and the resource or population could recover within the Seashore.

Major: would be substantial, highly noticeable, measurable, and potentially irreversible (permanent). The resource or population would be unlikely to recover within the Seashore with or without active management.

Species and Habitats of Management Concern

Numerous species of plants and animals have undergone local, state, or national declines, which has raised concerns about their possible extinction if they are not protected. Many of the plant and wildlife species, and habitats present in the project area are granted special protection through listing by the U.S. Fish and Wildlife Service (USFWS) and/or the State of California. The Marine Mammal Protection Act and the Migratory Bird Treaty Act afford additional protection.

Policies and Regulations

The USFWS and the CDFG have established lists that reflect the species' status and the need for monitoring, protection, and recovery. In addition to federal and state-listed species, potential impacts to plants listed by the California Native Plant Society also are considered for all programs and activities that the Seashore undertakes. The Seashore also recognizes a number of species as locally rare or of special concern, even though they are not officially listed. Collectively, species in all of these categories are referred to in this document as "special-status species."

The Federal Endangered Species Act, as amended, requires federal agencies to consult with the USFWS before taking actions that (1) could jeopardize the continued existence of any federally listed plant or

animal species (e.g., listed as threatened or endangered) or species proposed for listing, or (2) could result in the destruction or adverse modification of critical or proposed critical habitat. The USFWS provided upon request a list of species that must be considered for this FEIS. In Appendix E is a letter from USFWS confirming their concurrence with the NPS determination that the Preferred Alternative would not adversely affect listed species within the project area.

The Council of Environmental Quality Regulations for Implementing the National Environmental Policy Act (Section 1508.27) also requires federal agencies to consider if an action could violate federal, state, or local laws or requirements imposed for the protection of the environment. For this reason, species listed under the California Endangered Species Act (i.e., those considered endangered or threatened) by the California Department of Fish and Game are included in this analysis. Species proposed for listing in either of the two categories are also included.

NPS *Management Policies* 2001 state: "The National Park Service will identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats… The National Park Service also will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks, and their critical habitats… All management actions for protection and perpetuation of special status species will be determined through the park's resource management plan."

In addition, park managers are to ensure that park operations do not adversely impact endangered, threatened, candidate, or sensitive species and their critical habitats, within or outside the park and must consider federal and state listed species and other special-status species in all plans and NEPA documents (NPS-77, Natural Resource Management Guidelines).

NPS-77 states: "The following legislation, policies, and agreements provide the authority for NPS policies on management of threatened and endangered species: the Endangered Species Act; state-specific endangered species acts; other state wildlife statutes or agreements pursuant to Section 6, Endangered Species Act; the Migratory Bird Conservation Act; the Fish and Wildlife Coordination Act; the Wild and Scenic Rivers Act; the Marine Mammal Protection Act; the Bald and Golden Eagles Protection Act; the Wilderness Act; the Convention on International Trade in Endangered Species; and maritime and other international agreements."

The USFWS usually takes lead Departmental responsibility for coordinating and implementing provisions of the Endangered Species Act for all listed endangered, threatened, and candidate species, particularly for all terrestrial plants and animals and freshwater aquatic species. The NMFS is responsible for listed marine mammals such as Cetacea (all whales and porpoises), Pinnipedia (Steller sea lions, Hawaiian monk seals, etc.), and anadromous fish (steelhead, coho and Chinook salmon, etc.). In each instance discussed below, where the listed species in question is a fish, whale or pinniped, the term "USFWS" might more accurately read "NMFS" or "NMFS and USFWS." This is particularly true for any activity that may involve the "taking" of a marine mammal of special status fish species such as endangered salmon and steelhead trout. See Appendix E for the letter from NMFS stating their concurrence with the NPS determination that the preferred alternative would not adversely affect listed species in the project area.

The federal, state, and California Native Plant Society categories for special-status species are defined as:

Federal endangered: Any species that is in danger of extinction throughout all or a significant portion of its national range.

Federal threatened: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its national range.

California endangered: Any species that is in danger of extinction throughout all or a significant portion of its range in the state.

California threatened: Any species that is likely to become an endangered species with the foreseeable future throughout all or a significant portion of its state range.

California rare (plants only): A native plant that, although not currently threatened with extinction, is present in small numbers throughout its range, such that it may become endangered if its present environment worsens.

California Native Plant Society List 1A	Presumed Extinct in California
California Native Plant Society List 1B	Rare or Endangered in California and Elsewhere
California Native Plant Society List 2	Rare or Endangered in California, More Common Elsewhere
California Native Plant Society List 3	Need More Information
California Native Plant Society List 4	Plants of Limited Distribution

Assessment Methodology

Grazing by wild ungulates plays a role in the life history of many special-status species by removing understory and maintaining open habitat, encouraging reproduction in some species, and affecting competing species. Grazing can be detrimental to native plant species, especially when timing, frequency, and intensity are outside of the natural cycle to which the species is adapted (Archer and Smeins 1991). Grazing in California grasslands has been found to differentially affect various native life-history guilds such as annual or perennial forbs and grasses (Hayes and Holl 2003). Grazing can also indirectly affect protected wildlife at the Seashore by trampling vegetation and increasing the potential for siltation of waterways.

The following parameters have been used to evaluate the consequences of the various alternatives on special-status species:

- The species affected and its degree of local, regional, national, and global rarity.
- The rarity of the genotype or subspecies, regionally, nationally, or globally.
- The numbers of animals or proportion of the species range affected by the action.

Type of Impact

Adverse: likely to result in unnatural changes in the abundance or distribution of a special-status species. This could occur through direct disturbance, mortality, decreased reproduction, or through destruction or alteration of habitat.

Beneficial: likely to protect and/or restore the natural abundance and distribution of a special-status species. This could occur through increased survival, reproduction, or through increased availability of habitat or required resources.

Duration of Impact

Short-term: would immediately affect the population or species, but would have no long-term effects to population trends or species viability and a return to the original condition would occur within two generations of that species.

Long-term: would result in changes in the abundance and distribution of a special status species that persist for greater than two generations of that species or would lead to a loss in population or species viability—exhibited by a trend suggesting decline in overall species aerial extent or abundance.

Intensity of Impact

Negligible: imperceptible or not measurable (undetectable). For purposes of Endangered Species Act compliance, a negligible impact is equivalent to a finding of no effect.

Minor: slightly perceptible and localized in extent; if inciting stimulus ceased (i.e., browsing of riparian vegetation by non-native deer), adverse impacts would reverse and the resource would recover.

Moderate: apparent, measurable, or sufficient to cause a change in the resources (e.g., abundance, distribution, quantity, or quality). Less localized within the Seashore than a minor impact. Adverse impacts would eventually reverse with cessation of inciting stimulus and the resource would recover.

Major: substantial, highly noticeable, or with the potential for landscape-scale effects and major irreversible population effects with or without cessation of inciting stimulus.

Human Health and Safety

Management of park wildlife, whether on federal lands or on private property, can involve inherent risks to the health and safety to both visitors and staff. In a national park, wild animals can potentially cause disease transmission, vehicular accidents, or bodily injury to visitors or staff who come in direct contact with them. These risks are present whether or not wildlife are actively managed. These risks vary with the wildlife management technique used. The proposals analyzed, ranging from capture, immobilization and treatment of animals to use of aircraft and culling with firearms, can cause increased safety risks to managers and visitors. Management of deer also influences their population numbers and could contribute to the increase or reduction of auto/deer collisions.

Policies and Regulations

The NPS has a continuing concern about the health and safety of its employees and others who spend time in the parks. Several proposed deer management actions have the potential to increase risk to human health and safety. NPS *Management Policies* 2001 provide general guidance related to providing safe facilities and experience for the visiting public and park employees. The policy of the NPS is (1) to protect the health and well-being of NPS employees and park visitors through the elimination or control of disease agents and the various modes of their transmission to man, and (2) to ensure compliance with applicable Federal, State, and local public health laws, regulations and ordinances. Implementation of this policy would be qualified by the Organic Act's requirement that the NPS conserve the scenery and natural

and historic objects and the wildlife therein in such manner and by such means as would leave them unimpaired for the enjoyment of future generations.

Various NPS director's orders (described below) provide policy guidance for specific components of park operations and management, some of which are expressly related to risk management (occupational safety and health of employees and visiting public) (see http://data2.itc.nps.gov/npspolicy/DOrders.cfm).

The primary focus of Director's Order 50B is the occupational safety and health of NPS employees. Visitor safety and health is the focus of Director's Order 50C.

Director's Order 83 outlines what the NPS will do to ensure compliance with prescribed public health policies, practices and procedures. This order establishes NPS policy with respect to all public health activities within areas of NPS jurisdiction, regardless of whether those activities are carried out by NPS or other Federal employees, or by other organizations, including the U.S. Public Health Service. Public health includes illnesses associated with drinking water, wastewater, food safety, animal vectors, animal reservoirs, hazardous wastes, indoor air pollution, institutional sanitation, radiation safety, medical wastes, solid wastes, air pollution, and other related areas of environmental health.

Use of firearms by NPS Law Enforcement and Resources Management staff is directed by Director's Order 9, Law Enforcement Program, and Director's Order 77, Natural Resources Management Guidelines, respectively. NPS requires firearms training and certification for all employees authorized to use firearms in the performance of their natural resource management duties. Firearms training must include safety, marksmanship, maintenance, storage, accountability, control, and security. Risk to human safety is further mitigated by the limiting of shooting operations to non-peak times in high-visitation areas—ideally, early and late in the day, and potentially, area closures.

The use of chemical sterilant drugs in wildlife has safety implications for staff that administer the drug and humans that inadvertently consume treated animals. Use of chemical sterilants and other experimental drugs is outlined in Director's Order 77, Natural Resources Management Guidelines, regulated by 21 CFR 511ff, and allowed only after New Animal Drugs for Investigational Use permits have been issued by the Food and Drug Administration. NPS staff administering the drugs must receive a course of training as specified in Director's Order 77.

Director's Order 60 provides park managers direction on conducting a legal, safe, and cost effective aviation program, while minimizing adverse impacts that NPS aviation activities may impose on park resources and visitor enjoyment. In addition, the use of aircraft in national parks for wildlife monitoring or management activities is in accordance with Federal Aviation Administration regulations, as described in the 350-354 Department of the Interior Departmental Manuals.

Assessment Methodology

The effects of each alternative are evaluated by analyzing potential impacts to the health and safety of park visitors and employees. Specifically, the analysis assesses risks to human safety from the use of capture techniques, aircraft, firearms, contraceptive drugs and deer/vehicle collisions. The analysis does not review impacts to water systems that may be affected by sedimentation caused by increased numbers of non-native deer or decaying carcasses that result from management action. These impacts are discussed under the heading of Impacts on Water Resources and Water Quality.

Type of Impact

Beneficial: result in a reduction in human health and safety risks; or would improve human health or safety.

Adverse: result in additional or exacerbated human health and safety risks.

Duration of Impact

Short-term: are temporary (less than one month) and are associated with transitional types of impacts (e.g., safety concerns related to risks of helicopter overflights of ranches or dwellings).

Long-term: have a permanent effect on human health and safety (i.e., contamination of a water source for domestic use).

Intensity of Impact

Negligible: would not be detectable; increased safety risks are not measurable.

Minor: would be slightly detectable; increased safety risks are measurable but small and limited to few individuals.

Moderate: would be clearly detectable; increased safety risks could have an appreciable effect on human health and safety, in terms of magnitude of risk and number of people affected.

Major: would be clearly introducing a severe health hazard to large numbers of people, such as the introduction of a new disease or source of water pollution to a community.

Visitor Experience

This impact topic concerns not only the recreational opportunities at Point Reyes National Seashore (visitor access, permitted types of recreation) but also the character of the visitor experience as it pertains to what visitors perceive during their time at the Seashore. This experience can be affected by noise, visual distractions or other sensory intrusion resulting from project actions. Visitor experience can also be affected by perceived conflict between NPS management of resources and the social and ethical values of some visitors. An example of such a conflict is NPS wildlife control activities offending visitors who are animal welfare or animal rights proponents.

Visitor experience is also directly affected by actions influencing natural resources that constitute scenic resources (e.g., degradation of native plant communities could impact the visitor experience). Though impacts to these resources are not repeated in the analysis of visitor experience, enhancement or degradation of these resources also enhances or degrades the quality of the visitor experience. Impacts to viewsheds are discussed under this impact topic. Grazing or the absence of grazing can change the vegetation in an area, affecting the visual appearance of a landscape.

Policies and Regulations

Soundscape preservation and noise management activities are subject to the policies contained in NPS *Management Policies* 2001. The portions of the NPS *Management Policies* 2001 that are most pertinent to this topic are: Chapter 1, Introduction; Chapter 4, Natural Resource Management; Chapter 5, Cultural

Resource Management; Chapter 6, Wilderness Preservation and Management; and Chapter 8, Use of the Parks. Policies in the form of regulations covering general audio requirements are published in 36 CFR 2.12.

Director's Order 47, Soundscape Preservation and Noise Management, addresses the problem of excessive/inappropriate levels of noise. It directs park managers to: (1) measure baseline acoustic conditions, (2) determine which existing or proposed human-made sounds are consistent with park purposes, (3) set acoustic management goals and objectives based on those purposes, and (4) determine which noise sources are impacting the park and need to be addressed by management. Furthermore, it requires park managers to evaluate and address self-generated noise.

NPS *Management Policies* 2001 also specify that visitor activities that are appropriate to the park environment will be encouraged, whereas those that would impair park resources or are contrary to the purposes for which the park was established, will not be permitted. In reference to area closures, the NPS *Management Policies* 2001, as well as 36 CFR 1.5, allow superintendents to temporarily or permanently close a specific area to prevent unacceptable impacts to park resources and to protect visitor safety. Section 8.4 of the NPS *Management Policies* 2001 mandates that all necessary steps be taken to avoid or mitigate adverse effects from aircraft overflights in order to reduce adverse effects on resources and visitor enjoyment.

The issue of social values is a component of the visitor experience, as it relates to wildlife management actions ranging from behavior modification techniques to capture or killing of animals. It is an important and complex topic as the interpretation of what constitutes harm or suffering to an animal varies from person to person, with different people perceiving the humaneness of any given action differently (USDA 1997). In the past, some individuals and interest groups have objected to certain management techniques proposed by NPS units for management of non-native wildlife (Sellars 1997). A number of animal rights and welfare organizations and private individuals raised issues during public scoping for this document (see Chapter 5, Consultation and Coordination). All action alternatives contain options for proposed management of non-native deer within the Seashore and include either lethal removal through the use of firearms or the combination of the use of contraceptive and lethal removal techniques. Some members of the public may find proposed options objectionable for a variety of reasons related to social values (e.g., techniques are inappropriate; techniques are inhumane; management is not necessary). All alternatives considered in this FEIS require measures to minimize animal suffering and eliminate unnecessary pain and suffering to every extent possible (see Actions Common to All Alternatives).

There are no specific federal directives for NPS regarding social values related to animal welfare or animal rights. NPS management of wildlife, as described in the NPS *Management Policies* 2001 is based on a biocentric ethic and not on individual animals. The role of animal populations and species within the ecosystem, rather than individuals, is the focus. This "land ethic," as described by Aldo Leopold, can be seen as: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1970). NPS *Management Policies* 2001 mandate that NPS will maintain all native plants and animals as parts of the natural ecosystems of parks. In addition, rather than managing to preserve individual species, NPS will try to maintain all the components and processes of naturally evolving park ecosystems while keeping all intervention to the "minimum necessary" to achieve stated management goals (NPS *Management Policies* 2001, sec. 4.1).

NEPA does not consider animal rights or animal welfare to be an environmental issue or resource element. However, animal welfare issues were raised during public scoping. As an ethic held by a certain segment of the public, belief in animal rights and animal welfare can be considered part of the human environment and are therefore discussed as a part of the visitor experience. In addition, pain and suffering caused by proposed actions to individual animals are considered in the analyses of impacts to wildlife.

Wilderness experience and values are important to the a number of Seashore visitors who utilize its trails and enjoy its solitude and natural soundscapes. The regulations and policies governing the management of wilderness are discussed in detail in other sections of this EIS (see Chapter 1, Purpose and Need, and the Wilderness section of Chapter 3, Affected Environment, for example). Wilderness areas are to be administered "in such a manner as to leave them unimpaired for future use and enjoyment." This same language is part of the Organic Act of 1916, which created the National Park Service, and guides the management of all NPS resources and values. The Department of the Interior (NPS is a bureau of the Department) has interpreted this and other sections of the Act to mean that wilderness designation of national park system lands "should, if anything, result in a higher…standard of unimpaired preservation."

PRNS has completed a required assessment to determine whether actions in the proposed alternatives are consistent with this "minimum requirement concept." The assessment both evaluates whether intervention in wilderness is warranted, and whether the techniques proposed to conduct the needed activities would have the minimum impact to wilderness resources. The results of this assessment are included as Appendix A.

Assessment Methodology

The effects of each alternative are evaluated by analyzing potential impacts to visitor experience. The analysis assesses impacts to visitor recreation and enjoyment of the Seashore from the use of aircraft, firearms, and various wildlife management techniques. The essential features of wilderness and wilderness character as defined by the Wilderness Act and other sources (see Affected Environment) are its "wildness" and its "naturalness." These are both features that can be subjective and lend themselves to a qualitative discussion rather than a quantitative analysis. Therefore, the methods used in this EIS are primarily descriptive.

Type of Impact

Beneficial: result in an increase in visitor enjoyment and recreational opportunities.

Adverse: result in a decrease in visitor enjoyment and recreational opportunities.

Duration of Impact

Short-term: are temporary (less than one month) and are associated with transitional types of impacts (e.g., temporary area closures).

Long-term: have a permanent effect on visitor enjoyment of the Seashore.

Intensity of Impact

Negligible: would not be detectable by the vast majority of visitors.

Minor: would be detectable by a few visitors; impacts to the visitor experience are measurable but considered mild.

Moderate: would be clearly detectable by many visitors; impacts to the visitor experience are measurable and considered mild to moderate.

Major: would be clearly detectable by many visitors; the impacts to the visitor experience are considered to be major and would clearly affect visitation rates at the Seashore.

Park Operations

This topic addresses the effects on PRNS from the costs and staffing requirements of the proposed actions. It also addresses energy consumption and conservation potential of each alternative. Direct impacts are due to changes in funding and personnel while indirect impacts are caused by requirements for administrative support, office space, vehicles and energy use. PRNS currently has about 116 full-time equivalents (FTEs) and a total operations budget of $5.67 million

The operating budget for the PRNS deer management program in FY 2004 was $113,000. An additional $100,000 was made available through fee funds and grants set aside for specific management projects. Staffing for the deer management program is 3.0 FTEs.

Policies and Regulations

Congress established the NPS in 1916. To fulfill its mission, the NPS receives funding from both the federal appropriations process and other federal revenue sources.

Like most federal agencies, the NPS relies on federal appropriations to fund its core activities, although there is increasing use of alternative revenue sources, such as fees, to supplement operations. The NPS requests direct congressional funding and reports on the use of other federal funds through an annual budget document submitted to Congress entitled "Budget Justifications," or more popularly called, the “Green Book.”

The implementing regulations of NEPA require that environmental impact statements address the energy requirements and conservation potential of project alternatives. The NPS *Management Policies* 2001 require that all facilities be managed, operated, and maintained to minimize both energy consumption and consumption of nonrenewable fuels. The policies also require that new energy-efficient technologies be used where appropriate and cost effective.

Assessment Methodology

Impacts were evaluated by assessing changes that would be required to meet the operational requirements outlined in each of the alternatives. Relative costs were generated using staff estimates of funding, labor, and energy required to implement these actions. These effects were compared to existing operations, staffing, funding, and energy requirements at the Seashore.

Existing staffing levels were inventoried and assessments were made of current park operations. In addition, professional judgments by individuals who are most knowledgeable about various activities were used to anticipate the operational changes that would be needed under each action alternative.

Between 1972 and 1994, non-native deer were lethally removed by NPS staff as part of a control program intended to limit each species to 350 animals. From 1995 to 1998, a small number of animals were removed yearly for Native American festivals. Records of costs per deer culled, based solely on staff time and vehicle mileage, are available for 1984–1998 (NPS unpublished data (h)).

Estimates were made of the personnel and energy required to:

- provide education and information services to the public regarding deer management activities;
- provide law enforcement and aviation safety services during deer management activities;
- provide administrative support for deer management activities;
- provide training in deer management techniques and aviation safety; and
- conduct deer management activities.

These assessments were compared to existing staffing levels and energy use. It should also be noted that staffing funding and energy impacts for the action alternatives are difficult to project until final plans are completed. Thus, the estimates are intended to provide a general description of potential effects, considering the variability within the range of possible operational scenarios.

The discussions of impacts are for operations that would be new, undergo major change, or show susceptibility to increases or decreases in operational activity.

Type of Impact

Adverse: would represent an increase in operating costs and/or energy usage.

Beneficial: would represent a decrease in operating costs and/or energy usage.

Duration of Impact

Short-term: would last only until all actions are completed.

Long-term: would have a permanent effect on operations.

Intensity of Impact

Negligible: there would not be a measurable difference in costs and/or energy usage from existing levels.

Minor: additions or reductions in cost and/or energy usage would be less than 5% of existing parkwide budget (currently $5.6 million in general funds).

Moderate: additions or reductions in cost and/or energy usage would be between 5% and 15% of existing parkwide budget (currently $5.6 million in general funds).

Major: additions or reductions in cost and/or energy usage would be more than 15% of existing parkwide budget (currently $5.6 million in general funds).

Regional Economy

This topic concerns impacts of proposed NPS actions on businesses and livelihoods in Marin County, California. One of the objectives of this non-native deer management plan is: "to reduce impacts of non-native deer to agricultural permittees within pastoral areas. Such impacts might include direct consumption of forage, transmission of disease to livestock and damage to fencing" (Chapter 1, Purpose and Need). Livestock ranches within PRNS have sustained documented impacts from non-native deer management in the past and it is reasonable to evaluate impacts of future management to these ranches, as well as to ranches and farms outside Seashore boundaries. Also evaluated are impacts to local hotels, bed

and breakfast inns, restaurants and retail businesses from any anticipated park closures resulting from non-native deer management activities.

Policies and Regulations

The legislation establishing both PRNS and GGNRA included provisions for continuing the historic ranching uses on some of the lands acquired for these parks. As agricultural lands were purchased, sellers were allowed to continue dairying or beef ranching activities under one of two arrangements. They could retain a Reservation of Possession, under which they would forego a portion of the purchase amount in exchange for the right to continue ranching activities for up to 25 years. Alternately, they could sell outright and enter into Special Use Permit agreements of up to five years with the park. Some sellers retained an Reservation of Possession on part of their land, and entered into Special Use Permit agreements for the rest, while others have entered into more than one Special Use Permit agreement with the Park.

The 24 ranchers currently operating within the project area hold 11 Reservations of Possession and 30 Special Use Permits. Most of the Reservations of Possession expire in the next decade. It has been the policy of PRNS in the past to allow ranchers whose Reservation of Possession terms expire to continue ranching operations under Special Use Permits. Together these permittees and Reservation of Possession holders support approximately 6,013 cattle on a year-round basis.

Assessment Methodology

Alternatives were evaluated for their socioeconomic effects on local communities. Socioeconomic effects include potential direct effects of property loss and potential indirect effects in economic terms, resulting from deer depredation of livestock forage, damage to fences, reseeding pastures, and potential disease transmission to livestock. Also evaluated are direct effects of property loss and potential indirect effects of park closures. Alternatives were evaluated for their effects on minority and low-income populations and communities as well as their effects on the local community at large.

Estimates of economic impacts to ranchers within the Seashore were obtained from the ranchers themselves. A number of ranchers have no non-native deer on their ranches and others see a few fallow or axis deer seasonally. Four of the 13 ranching permittees see either or both species year-round, in varying numbers. One ranching operation leasing pasture on the Vedanta Society property in Olema also experiences large numbers of fallow deer year-round. Impacts to other agricultural operations outside NPS boundaries were determined through extrapolation of impacts within the Seashore and through conversations with ranchers and farmers.

Type of Impact

Adverse: degrades or continues to negatively affect the characteristics of the existing economic environment, as it relates to local communities including local ranchers and farmers, minority and low income populations, visitor population, regional economies.

Beneficial: improves characteristics of the existing social and economic environment, as it relates to local communities including local ranchers and farmers, minority and low-income populations, visitor population, regional economies.

Duration of Impact

Short-term: temporary and typically transitional; associated with implementation of an action.

Long-term: continues beyond the implementation of an action and may constitute permanent impacts on the social and economic environments.

Intensity of Impact

Negligible: undetectable and expected to have no discernible effect on the economic environment.

Minor: detectable for a few local businesses and not expected to have an overall effect on the character of the economic environment.

Moderate: detectable in a moderate to large number of local businesses or could have the potential to expand into an increasing influence on the economic environment.

Major: a substantial, highly noticeable influence on many local businesses, and could be expected to alter those environments permanently.

Environmental Consequences of Alternative A – No Action

No Action is the continuation of current management. As noted in Chapter 2, Alternatives, current management of non-native deer is restricted mainly to monitoring activities, with no attempt to reduce numbers or control distribution.

Historical deer counts, current population parameters and population models indicate that current population levels of both non-native deer species are below carrying capacity and consequently, the No Action alternative would likely result in increased numbers of both axis and fallow deer in the Seashore. Alternative A would also likely result in increasing numbers of non-native deer outside of the Seashore. Expansion rates of non-native deer would depend on a number of factors beyond the control of PRNS, namely, range conditions and hunting pressure.

Impacts on Water Resources and Water Quality

Analysis

Grazing animals primarily affect water quality through activities that increase the potential for erosion or stream destabilization. They may also increase bacteria or nutrients in water through defecation in or near streams. Fallow deer, because they form large groups and remain in certain areas for prolonged periods, cause impacts due to congregation. These impacts resemble those of confined animals, such as domestic livestock.

Some information is available in the literature about the extent of water quality effects resulting from deer populations. Unlike native black-tailed deer, both fallow and axis deer congregate in riparian areas in groups, as do cattle, because vegetation in riparian areas tends to be more succulent year round. Cattle and non-native deer are known to occupy riparian areas even when their preferred foods have been eaten, particularly in the summer when they seek shade under willows and other vegetation. Cattle seem to prefer streamside forests, and this has led to impacts, some of them severe, researched and noted in other parts of the country. Although the extent of impacts from much smaller and lighter axis or fallow deer are

not likely to be as severe, they do have similar grazing styles (e.g., both graze on grass year round, although deer supplement their diet with forbs to a greater extent) and so may have similar types of impacts. Because the information about the specific impacts of non-native deer at the Seashore on water resources is limited, those known to result from grazing by cattle and other ungulates are described in order to understand the impacts of non-native deer. It should be noted that cattle are excluded from many sensitive areas of the Seashore (such as riparian areas), therefore the impacts discussed below, are mitigated within NPS boundaries.

When large numbers of cattle periodically graze in riparian areas, or when smaller numbers repeatedly or continuously graze near rivers and streams, trampling and consumption of vegetation reduce the ability of these forests or shrublands to trap sediment from upland runoff. Also, because riparian soils are wetter, and because these areas are flat bottomlands, soils there tend to be more vulnerable to compaction (Hubert et al. 1992). Compaction interferes with the water storage function of riparian zones and increases the potential for runoff, which in turn can alter the normal hydrology of a stream or creek. In one study, researchers found an increase of 210% in runoff volume in an area of pine and bunchgrass forest where moderate cattle grazing had occurred, and an increase of 325% in an area where heavy cattle grazing took place.

The amount of runoff is directly related not only to compaction of soil, but to the amount of unvegetated area. Fallow and axis deer are known to create trails and open areas in the Seashore and elsewhere (NSW Scientific Committee 2004; Fellers and Osbourn 2006), especially when they congregate. Fallow bucks, during the breeding season, commonly thrash riparian vegetation with their antlers and have been observed to girdle and destroy riparian saplings (Fellers and Osbourn 2006; see Figures 13-16) Twenty-five percent of fallow deer leks (breeding areas) were observed to be in riparian areas and over 80% of these leks contained bark damage to trees or shredded foliage. A study of cattle grazing found 51% more runoff, related to the degree of bare patches, after 3 years of moderate grazing. Fallow deer trails in the Seashore are heavily frequented and easy to distinguish from native deer trails because they are wide, cross creeks and their soils are easily destabilized and subject to erosion (see Figure 16). These areas have the potential to deliver soil directly to the stream channel without filtration by riparian vegetation and to increase runoff. Increases in runoff can translate to more frequent flooding, increased flows and downstream erosion, and changes in side channel or other aquatic habitat. The loss of riparian vegetation from trampling or consumption also means upslope flows and sediment run more freely into streams and rivers, increasing sedimentation and total suspended solids.

Both cattle and deer can have large-scale impacts on riparian areas by consuming vegetation. Cattle can eat virtually 100% of the vegetation in a riparian area if they remain in it long enough, or are numerous enough to do so. Under these conditions, they are known to eat lower branches of willows, and all palatable forbs or grasses. Although fallow deer are smaller than cattle, if they occupy a riparian area for a long period of time, as they do during the dry season or the breeding season, they have been observed to exert noticeable loss of vegetation in that area through grazing and browsing (Fellers and Osbourn 2006). Seashore riparian areas often provide the last remnants of green vegetation at the end of summer and during droughts. In addition, fallow deer bucks tend to aggressively rub and thrash their antlers during the reproductive season or "rut," causing destruction of riparian vegetation. Impacts of fallow deer thrashing are most acute within the pastoral zone in Olema Valley, where many riparian areas have been deliberately excluded with fencing from livestock grazing to restore canopy and natural hydrologic processes. In these areas, revegetation efforts and natural regrowth have been severely retarded due to heavy grazing and antler rubbing by the non-native deer (B. Ketcham, NPS, personal communication). Seasonal thrashing and girdling by fallow deer kills young trees and prevents native riparian plants from growing beyond shrub height. Unlike cattle, non-native deer cannot be excluded from sensitive riparian areas by conventional fencing.

The removal of vegetation can indirectly affect water quality. Without the benefit of the root structures vegetation provides, soil is loosened and washed into nearby streams or rivers during the next rainy period. In addition, soils in the immediate vicinity are more likely to be washed into the water column, and as noted above, the ability of these riparian zones to trap upslope sediment and runoff is diminished. This increase in runoff and sedimentation is sometimes aggravated by the destabilization of streambanks caused by congregating animals. One study on cattle (Hubert et al. 1992) found 80% more stream channel instability in a grazed area in Montana than a similar one that had been ungrazed. Stream bank loss and increased erosion resulting from denuded areas, compaction of soils and increased runoff, can add enough silt to a stream to increase levels of total suspended solids and change stream morphology. For example, in one study in northeastern Utah, the depth of stream adjacent to an area where cattle grazed decreased from 33 cm to 8 cm; the width increased as banks destabilized; and the riffles and gravel used by fish to spawn were covered in silt (Hubert et al. 1992). Eventually, this caused a change in the fish populations along strips of stream where cattle were grazing. Another study of Rock Creek in Montana found a 317% greater fish biomass in sections along ungrazed areas. Sedimentation associated with grazing also changed fish species composition, with whitefish and suckers occupying sections where total suspended solid levels were higher and trout occupying areas without grazing.

These alterations have implications for watersheds and aquatic life at the Seashore. For example, in at least three of the park's watersheds, Olema, Lagunitas and Pine Gulch, four species of concern occupy streams and creeks. These species are coho and Chinook salmon, steelhead and California freshwater shrimp. As noted in Affected Environment (Chapter 3), these species are dependent on riparian vegetation for cover and shade, and would require uncovered gravel for spawning and specific stream conditions for habitat and spawning success. The loss of this vegetation, streambank failure and increased runoff and erosion would alter habitat for any or all of these species in these watersheds, as fallow deer are known to occupy all three watersheds. For example, at one riparian restoration area in particular, John West Fork of Olema Creek, the park has erected fences to keep cattle out of riparian zones. Although livestock have been successfully excluded, fallow deer have found their way into the area (likely under the fences) and NPS staff has observed extensive damage to native willow in these areas (B. Ketcham, NPS, personal communication). As a result, it has taken five years since exclusion for willows to grow beyond waist height. Riparian restoration and planting projects conducted in wilderness and natural areas where densities of fallow deer are much lower (i.e., Muddy Hollow Culvert Restoration Site) have shown much more rapid vegetative recovery (NPS unpublished data (i)).

Cattle are known to also contribute fecal coliform and fecal streptococcal bacteria as well as increases in nitrates and phosphate to streams. If cattle are grazing close enough to a stream, their waste is washed into the water column during heavy rains. This is particularly true when animal density or grazing pressure is high. PRNS monitoring has shown that high levels of sediment and pathogens, resulting from livestock, may enter streams from localized sources and yet persist for 1–2 km. downstream (NPS 2001c). This is possible for non-native deer as well, as increased levels of indicator bacteria have been attributed to wildlife in published studies (Hubert et al. 1992) and fallow deer and axis deer (unlike native black-tailed deer) are found in large, high-density herds at PRNS (NPS 2002a).

The impacts described above to hydrology, stream morphology, aquatic habitat and water quality are currently considered minor to locally moderate, as defined in the Assessment Methodology section and depending on the area in the park. However, because fallow and axis deer would continue to be unmanaged in Alternative A, impacts would increase to moderate intensity and persist indefinitely. Over the 15-year period of time covered by this plan, impacts would spread in the park as the population spreads, and would worsen as axis and fallow deer continue to return to riparian areas.

It is highly likely that axis and fallow deer would expand their range outside the park within the next 15 years under Alternative A. Expansion of non-native deer populations beyond park boundaries could

adversely impact riparian vegetation and water quality restoration activities occurring on private agricultural lands. Through various organizations, most notably the Marin-Sonoma Resource Conservation District, efforts to restore riparian corridors in the Walker and Chileno Creek watersheds have been made in conjunction with private agricultural operators. Long reaches of these streams have recently been excluded from cattle access with fencing and planted with willows and other riparian vegetation species. Expansion of deer populations outside Seashore boundaries would retard success or deter implementation of such riparian restoration projects due to reduced recovery rates and the perceived benefit associated with these projects.

In addition to affecting restoration efforts, the expansion of range for both axis and fallow deer would result in regional effects on water quality and hydrology. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests) exists in close proximity to PRNS, GGNRA and throughout Marin and Sonoma Counties. The successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, adverse long-term impacts to water resources such as those described above could be much wider spread and approach major in intensity.

Unlike with livestock, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of non-native deer to the water resources and water quality.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As noted above, Alternative A could have direct and indirect moderate adverse effects on the water quality and hydrology of many of the park watersheds. An assessment of cumulative impacts on water quality and hydrology considers the potential impacts that Alternative A may have on water quality in conjunction with the impacts on this same set of water resources from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for water resources include:

- current dairy and beef grazing
- the Giacomini wetlands restoration project
- Fire Management Plan implementation projects
- coastal watershed restoration (geomorphic sites) in Drakes Estero watershed
- Drakes Estero watershed restoration projects
- sewage system improvements
- small restoration projects within the Seashore

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Current and future livestock grazing and dairying. Within the Seashore, livestock agriculture continues, as instructed by Congress in its Point Reyes Seashore implementing legislation, in the form of concentrated dairy and beef operations. Historically, heavy stoocking levels were maintained that impacted hydrology, aquatic habitat and water quality within the Seashore.

The NPS grants to individual ranchers Special Use Permits which describe the terms of the lease. The Permits may contain requirements to modify agricultural operations in order to reduce the adverse impacts of livestock concentration. Whereas ranching operations once occupied the entire Point Reyes Peninsula, only 25% of the area remains currently in agriculture and the remaining 75% is managed as natural lands or wilderness areas. Within the 28,000 acres leased for agricultural, livestock has been successfully excluded (through fencing and other strategies) from 7,000 acres with sensitive resources, such as riparian zones and waterways. Cattle stocking has also been reduced by about 50% from approximately 12,045 head at the time of the park's establishment to 6,013 head at present.

The NPS shares management responsibility for the Tomales Bay Watershed, the Lagunitas Creek watershed, the Pine Gulch Creek watershed, Bolinas Drainages, Olema Creek watershed. Of these watersheds, the NPS manages the majority of lands in the Olema Creek and Pine Gulch watersheds (approximately 90% and 85% of the land is within the Seashore, respectively). The NPS has exclusive management responsibility for all of the Pacific Drainages (Kehoe, Abbotts Lagoon etc.), Drakes Bay, and Drakes Estero watersheds.

Tomales Bay, Walker Creek and Lagunitas Creek are all in the 45-square mile Tomales Bay Watershed, of which the NPS manages approximately 28%. These water bodies are listed by the State of California, under the Clean Water Act, as impaired by excessive levels of sediment, nutrients and pathogens. Waste from cattle is a primary contributor to the exceedences for nutrients and pathogens. Overgrazing and damage to channel banks from cattle is one of the contributing sources of high sediment levels, along with road failures, slope failures and landslides etc.

The State of California is required by the EPA to develop programs to reduce the Total Daily Maximum Load (TMDL) for each of the listed pollutants in these three water bodies by 2010. Actions to reduce pollutants and pollution within the Seashore, specifically in Lagunitas and Tomales Bay watersheds, have been developed to contribute directly to the State's restoration responsibilities.

The NPS and the Seashore's permittees have been working together, strategically modifying their operations to reduce impacts on water quality. For example, in the Kehoe Lagoon watershed (including North Kehoe and South Kehoe Creeks and tributaries), the beach monitoring program (in conjunction with the County of Marin), "posted" the area for exceedences of indicator bacteria (fecal coliform, *E.coli*, and *Enterococcus*) for water contact recreation several times in 2003. Kehoe Beach itself (saltwater) has consistently met the standards. The nearby dairy cattle operation undertook a barn expansion to increase the number of cows that are housed indoors to reduce pollution. Water quality data before and after the barn expansion will be monitored to determine the effect on water quality.

The Abbott's Lagoon watershed has recorded high fecal coliform levels in tributaries to the Lagoon during winter rains. The adjacent dairy built a barn in 2003 to house cattle and improve waste management. Preliminary results from the winter of 2004 indicate a marked decrease, compared to previous winters, in fecal coliform counts at two of the three monitoring sites. The average for the three sites was 8,700 MPN/100mL down from a high average of 10,000 MPN/100ml. Although this number still exceeds standards for non-contact recreation, additional decreases are anticipated in the next several years as operations become fine-tuned.

The Seashore has several other restoration projects planned or underway that would help improve water quality in Tomales Bay and other water bodies. Approximately, nine miles of fencing has been installed throughout the park to protect sensitive resources such as riparian corridors and wetlands and improve water quality. Focused monitoring of Kehoe Creek and Abbott's Creek has been initiated in order to differentiate sources and allow for more strategic siting of additional fencing (NPS 2004b).

When the effects of past, present and future ranching and dairying are viewed incrementally with the potentially adverse impacts of Alternative A, the impact results in exceedences for Tomales Bay and in smaller systems. The water quality impact is therefore apparent, local, and with the potential for regional effect. The impact is long-term, moderate and adverse on park and shared water resources.

The Giacomini Marsh Restoration would restore 550 acres of pasture and rangeland to coastal marsh habitat. The project would reverse the loss of 60% of Tomales Bay wetlands which occurred in the 1940s when the coastal marsh was diked for a dairy operations. Restoring connectivity between Tomales Bay and the dairy will improve water quality not only within the Project Area, but within the entire Bay. The project will increase filtering of nutrients, contaminants, and sediment coming into the Bay from Lagunitas, Olema, and Bear Valley Creeks. In addition, hydrologic modeling indicates that the proposed restoration alternatives would have a considerable beneficial impact to reduce flooding of adjacent properties and county roads, improving overall wetland functions such as floodwater retention. A project objective is to enhance water quality by creating a marsh filtration system to increase natural resource protection over a localized area while enhancing water quality throughout Tomales Bay and surrounding Pacific Ocean waters. With the potential to have apparent localized and possibly regional effects, the Giacomini Marsh Restoration, would have a beneficial, long-term moderate impact on water quality.

Fire Management Plan for Point Reyes National Seashore. Up to 3,500 acres annually could be burned or mechanically treated over the next decade as a result of the Fire Management Plan. The EIS for the Fire Management Plan concluded that impacts to water quality and watershed characteristics would be a long-term, beneficial moderate to major effect on park and shared watersheds by implementing project that reestablished natural hydrological processes and reduced fuel loads and the potential for catastrophic wildfire (NPS 2004). The annual work plan for the park is reviewed each year to ensure that annually no more than 10% of an individual watershed is disturbed by Fire Management Plan actions. At all phases of project implementation, erosion and sediment transport will be strictly controlled by erosion control techniques and avoidance of potentially high source areas. Over the short-term, the fire management plan would have minor, adverse, short-term impacts to water quality from ash or increases in erosion and suspended solids. Minor impacts to water quality and hydrology are defined as those that are slightly perceptible, without potential to expand and of localized extent.

Coastal Watershed Restoration (Geomorphic Sites) in Drakes Estero Watershed. The Coastal Watershed Restoration – Geomorphic Sites Project is currently in the planning stage. An Environmental Assessment on the proposal was circulated in 2004. The project would restore natural hydrologic function and increase estuarine habitat at Muddy Hollow Dam, Limantour Beach Dam and the Glenbrook Road Crossing by removing these barriers to tidal action. Impacts to hydrology and water quality under the selected alternative would have a short-term minor to moderate, localized adverse impact following project implementation. Though there would be shifts in water regime and channel and estuarine configuration following barrier removal, adaptive management measures such as installation of passive grade control would mitigate short-term impacts. The project actions would primarily have localized effects resulting in a beneficial, long-term minor to moderate impact on hydrologic and estuarine processes.

Drakes Estero Road Crossing Improvement Sites. This project proposes improvements to 6 culverted creek crossings within 3 coastal subwatersheds, all of which eventually drain to Drakes Estero and Drakes Bay. All are on perennial drainages or creeks that have flowing water throughout the year. The potential impacts associated with implementation of the project on hydrologic process, geomorphic process, and water quality are adverse, and minor to moderate in the short term. Short-term impacts include excavation of stream channel banks and beds, soil compaction and erosion due to heavy equipment traffic. Localized moderate impacts are expected at sites that would include installation of boulder cross-vanes or large-scale riprap armoring along with structure replacement. The restoration of more natural

hydrologic and geomorphic process to these watersheds would be beneficial in the long term. In the long term, there would be no adverse effect on water quality.

Sewage Systems Improvements. The NPS has completed sewage systems upgrades at visitor and staff structures throughout the park. All improved systems result in beneficial impacts to groundwater quality and to surface water in ponds, drainages and creeks by reducing the potential for leaching or leaking of contaminants. New, major septic systems are planned for the Home Ranch, the Point Reyes Lighthouse, the Point Reyes Hostel and upgrades are planned for the Drakes Beach system. These projects would have minor beneficial long-term effects on water quality by reducing sources of localized pollution.

Small creek restoration protection projects in Olema Valley for coho salmon and steelhead trout will include bank stabilization and fencing to exclude cattle. These projects would have a long-term, minor beneficial impact on the water quality of Bear Valley, Pine Gulch and Olema creeks.

Activities outside park boundaries that have an adverse effect on the same watersheds as those affected by non-native deer include four dams on Lagunitas and Nicasio creeks in the Lagunitas Creek watershed, and historic heavy logging on the Pine Gulch Creek watershed. Drake's Estero is also susceptible to nutrient inputs from grazed lands within the watershed and from increased sedimentation resulting from the Vision Fire. Beneficial cumulative effects on park watersheds have resulted from restoration planning for the Bolinas Lagoon (into which Pine Gulch Creek flows), riparian cattle exclusion fencing, and habitat restoration in the Olema watershed.

Based on the large geographic scope of the non-native deer effects on water in Alternative A, the adverse impacts on water resources would not be significantly offset by the beneficial impacts of some the above projects and, along with continued cattle ranching, would continue to present a long-term, adverse, moderate to major impact on the water quality and hydrology within the park and beyond the park boundaries.

Conclusion

Based on current and past data on fallow and axis deer, non-native deer populations would continue to increase, resulting in expanded range and higher animal concentrations within the Seashore and Marin County. While current direct and indirect impacts to water quality and hydrology from Alternative A would be minor to locally moderate, continued growth and expansion of the population would result in impact intensity increasing inside the park to moderate in the long term. This would not constitute an irreparable impairment of the park's water resources though impacts would be locally noticeable and with the potential to be apparent throughout the park. As the range of each species expands countywide, the potential for moderate to major impacts outside the park becomes greater.

Alternative A presents no means that would counter the expansion of the range and population of non-native deer nor any strategies to limit the direct and indirect impacts of non-native deer on water quality and hydrology. None of the projects described in the cumulative assessment of impacts to water quality would impede the continued, unlimited spread of non-native deer outside of the park. Though the cumulative impact scenario describes several restoration, rehabilitation and facility improvement projects that incrementally represent a substantial improvement to park and vicinity water resources, only the marsh restoration project would provide some treatment of water quality degraded by concentrations of non-native deer in Olema Valley. Non-native deer would continue to pass through the fences protecting sensitive resources from cattle. The adverse impacts of Alternative A on water resources would not be significantly offset by the beneficial impacts of some of the projects considered in the cumulative analysis and, along with continued ranching, would continue to present a long-term, adverse moderate to major impact on the water quality and hydrology within the park and beyond the park boundaries.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate in the park; potentially major outside the park
Cumulative Impact:	Adverse, long-term moderate to potentially major cumulative impacts to water resources and water quality within the park and beyond park boundaries.

Impacts on Soils

Analysis

Soils could be affected by non-native deer in several ways; through direct mechanical compaction or disturbance, through erosion related to the loss of overlying vegetation, through the addition of nutrients in waste products, and by more subtle changes in soil characteristics related to physiological responses of vegetation to grazing.

The project area includes lands both east and west of the San Andreas Fault. Soils to the east of the fault are derived from the Franciscan complex, which are typically dominated by clay-sized particles (loam) with a lower capacity for water infiltration and storage. Franciscan-derived soils are highly sensitive to compaction, resulting in more rills and gullies related to increased runoff rates. To the west of the San Andreas Fault, soils are more organic and typically have a sandier quality. These soils are usually deeper and have higher rates of infiltration. While somewhat less susceptible to compaction, these soils are highly erosive when disturbed. The soils are less cohesive and more subject to erosion associated with rainfall and surface runoff.

Soil compaction may occur when large numbers of non-native deer or other large animals congregate in one area for long periods of time, or when vehicles are driven off road for non-native deer management activities. As noted in other sections of this document, fallow deer are known to congregate in large herds and occupy areas for prolonged periods of time. This increases both the likelihood and the intensity of soil compaction. When soils are compacted, the bulk density increases and the rate of infiltration decreases, which ultimately means an increase in runoff. One study of cattle grazing in Colorado found bulk densities averaged 21% higher in areas grazed than in similar, ungrazed areas (Hubert et al. 1992).

Compaction may be more likely in the moist soils of flat bottomlands adjacent to riparian areas, but use of steeper areas by axis or fallow deer is also likely to increase the potential for erosion. Soils east of the San Andreas fault, which are more likely to experience compaction, would be particularly affected along bottomlands or riparian areas, while the organic soils west of the fault, along steeper slopes, would be subject to erosion. Axis deer on Lanai'i in the Hawaiian Islands are known to occupy both bottomlands and valleys and move up slope as browse disappears or the population expands (Dorman 1997). Axis deer were imported first to Moloka'i from India as a gift to King Kamehameha from the people of Hong Kong in 1868; in fewer than 100 years the population had expanded to 7,000 and have caused extensive documented loss of soils through grazing and breaking trails (Dorman 1997).

As described above in the Water Resources and Water Quality section, and below in the Vegetation section, non-native deer also affect soil indirectly by trampling and consuming vegetation. These deer can remove substantial quantities of vegetation, particularly when they congregate in large groups and remain in an area for a period of time. Studies have found that even moderate grazing by fallow deer can result in noticeable increases in open, unvegetated areas. For example, monitoring of a reintroduced herd of Persian fallow deer in northern Israel found that even low deer densities (less than 1 per acre) resulted in clear increases in the amounts of amount of open, unvegetated soil compared to a control area (Bar-David

et al. 1998). This same population also created unvegetated open areas by breaking trails through chaparral.

A recent study of PRNS fallow deer lekking behavior during the seasonal rut documented that trampling and thrashing of riparian vegetation, trailing near streams and destruction of riparian trees is a common occurrence (Fellers and Osbourn 2006). Fallow deer trails in the Seashore are heavily frequented and easy to distinguish from black-tailed deer trails because they are wide, cross creeks, are easily destabilized and subject to erosion (B. Ketcham, NPS, personal communication). These areas have the potential to deliver soil directly to a stream channel without filtration by riparian vegetation. In seasonal rutting areas, fallow deer have been observed to denude, and then scrape and tear at the soil. Scraped areas as large as 32 meters across and ruts as deep as 0.6 meters have been observed inside the park (Fellers and Osbourn 2006). The extent of damage in late fall is severe in some forest and shrubland areas. Fallow deer leks, characterized by denuded and scraped areas, have been found in the Estero Trail and Bear Valley area in densities of 28.4 and 78.8 per square kilometer respectively (Fellers and Osbourn, 2006) (see Figures 13-16). It is estimated that at least 120 acres of park lands are affected by lekking damage.

When vegetation is removed through trampling, scraping and tearing, breaking trails, or consumption of vegetation, soils are no longer held in place by the subsurface root structure and are much more subject to erosion during precipitation events. Park biologists have observed more erosion along the trails and in the rutting areas of non-native deer than in similar undisturbed areas.

Once initiated, compaction and soil loss from erosion can last for a long period of time. This is because vegetation is less likely to grow in soil that has been compacted, or where top organic layers have been removed through erosion. This long-term or permanent cycle of erosion and vegetation loss occurs particularly when compaction or erosion is severe.

Deer and other herbivores can change the characteristics of soil through their urine and feces, which return carbon and nutrients to the soil in labile forms, and enhance the nutrients in the soil around roots. This can increase plant growth and net primary productivity at a landscape scale, although the loss of vegetation caused directly by grazing decreases productivity.

Grazing cause physiological changes as well, which can translate into chemical changes in soil. For example, in some forests where nutrients are often not readily available (because they are locked up in the litter, which decomposes very slowly), deer would browse selectively on the most nutritious plants and then leave, taking the nutrients with them and making the system more nutrient poor. This also, in turn, reduces the activity of soil microbial organisms. On the other hand, in large grasslands, herbivory at low or moderate levels can stimulate a short-term increase in carbon in plant roots. This can lead to increased soil microbial biomass and net production of nitrogen by these microbes, which then becomes available for uptake into the plant shoots. One study that mimicked grazing by clipping found short-term increases in biomass and increased nitrogen in grass stems (Ayres et al. 2004). Heavy grazing in grasslands reduces the concentrations of carbon and nitrogen in both roots and litter (Mapfumo et al. 2002).

The impacts of grazing and breeding behaviors, including denuding of sites, increased soil compaction and disturbance, runoff and loss, changes in nutrients and changes in chemical properties, are currently present on more than 120 acres and would only increase in geographic scope and intensity at the Seashore if Alternative A were implemented. Overall, the impacts to soil from these behaviors are currently considered to be adverse and moderate in intensity. Under Alternative A, these impacts in the park would continue into the foreseeable future and would be long-term.

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and

eastwards, spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests) exists in close proximity to PRNS, GGNRA, and throughout Marin and Sonoma Counties. The successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some adjacent counties is likely. Should non-native deer populations expand outside NPS boundaries, adverse long-term impacts to soils could occur on more than 500 acres of ground and would therefore be characterized as major.

Unlike with livestock, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of non-native deer to soil resources.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As noted above, Alternative A impacts to soils from non-native deer inside the park would likely remain moderate and expansion of the populations outside the park could result in major adverse impacts to soils through compaction and loss. An assessment of cumulative impacts on soils considers the potential impacts that Alternative A may have on soils in conjunction with the impacts on the same soils from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact for soils include:

- current and future livestock grazing and dairying
- the Giacomini Wetlands restoration project
- Fire Management Plan implementation projects
- coastal watershed restoration (geomorphic sites) in Drakes Estero watershed
- Drakes Estero watershed restoration projects
- sewage system improvements
- small restoration projects within the Seashore

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Current and future livestock grazing and dairying. Within the Seashore, livestock agriculture, as instructed by Congress in its Point Reyes Seashore implementing legislation, continues in the form of concentrated dairy and beef operations. Historically, heavy stocking levels had impacts on hydrology, aquatic habitat and water quality within the Seashore.

The NPS grants to individual ranchers Special Use Permits which describe the terms of the lease. The Permits may contain requirements to modify agricultural operations in order to reduce the adverse impacts of livestock concentration. Whereas ranching operations once occupied the entire Point Reyes Peninsula, only 25% of the area remains in agriculture with 75% managed as natural lands or wilderness areas. Within the 28,000 acres leased for agriculture, livestock have been successfully excluded (through fencing and other strategies) from 7,000 acres with sensitive resources such as riparian zones and creeks. The concentration of cattle has also been reduced by about 50% from approximately 12,045 head at the time of the park's establishment to 6,013 head at present.

The primary impact to soils is through compaction, disturbance, erosion and addition of nutrients. These same types of impacts are caused by cattle in the form of dairy and beef operations on Seashore lands. Soil compaction and denudation is a concern related to both historic and current livestock operations. The

National Park Service conducts Residual Dry Matter surveys on pastoral lands to ensure that livestock do not denude the land through overgrazing. Techniques to mitigate overgrazing, including fencing, stocking rate reduction and rotational grazing, have been implemented with success.

Soil compaction is a problem associated with all concentrated animal operations. Soil compaction outside of the pastoral zone is likely a direct result of non-native deer, which unlike native black-tailed deer, are found in large herds. Within the pastoral zone, because deer can access areas fenced off to cattle, they would increase the level of compaction beyond that caused by cattle. Because the total number of acres heavily impacted by dairy and beef operations in the park is already approximately 1,300 acres, the adverse cumulative impact of deer in Alternative A, along with cattle gazing, is considered major. The acreage of soils impacted by ranching in the Seashore has been markedly reduced by active management and other mitigation measures such as fencing, stocking rate reductions and the removal of pastures from grazing and silage production. The current impacted area may be further reduced by further mitigation planned for the next 5 years.

Fire Management Plan. Impacts to soils from the anticipated fire management actions include changes in soil productivity and chemistry, as well as erosion following the removal of vegetation. The impacts on soils from increased erosion of prescribed burning and the average wildland fires (no more than about 30 acres per year), under the selected alternative, would be negligible to minor. Moderate to major, short to long-term, adverse cumulative impacts to the physical, chemical, and biological properties of soils from a very large or catastrophic wildland fire are possible under the selected alternative. Suppression activities could have additional adverse, short to long-term moderate to major impacts from soil compaction, mixing, reduced infiltration, loss of vegetation, and changes in soils that prevent quick revegetation. Actively suppressing wildland fires before they reach sensitive resources could keep impacts from becoming major and adverse. Because of the potential for a catastrophic fire, cumulative impacts of the fire management plan with Alternative A are considered major (the combined effects would be greater than 500 acres). However, normal fire activities in the Fire Management Plan —prescribed fire, mechanical treatment, and small wildfires—would have only a negligible to moderate effect on soil resources.

Coastal Watershed Restoration (Geomorphic Sites) in Drakes Estero Watershed, Drakes Estero Watershed Restoration Projects, Coastal Dune Restoration, Giacomini Wetlands Restoration, Sewage System Improvements, and Small Restoration Projects within the Seashore. These projects generally have short-term impacts to soils, but long-term beneficial impacts. The Giacomini and Coastal Dune Restoration projects will temporarily disturb a large number of acres (approximately 900), but the long-term effects will be beneficial to soil structure.

Based on the large number of acres with soil impacts in Alternative A, the adverse impacts on soil resources would not be significantly offset by the beneficial impacts of some of the above projects and, along with continued cattle ranching, would continue to present a long-term, adverse moderate to major impact on the soil resources within the park and beyond the park boundaries.

Conclusion

Based on current and past data on fallow and axis deer, non-native deer populations would continue to increase, resulting in expanded range and higher animal concentrations within the Seashore and Marin and Sonoma Counties. No impairment to soils would occur from implementing Alternative A. All of the impacts associated with the presence and/or expansion of these populations are characterized as adverse. Impacts to soils from non-native deer inside the park would likely remain moderate and expansion of the populations outside the park could result in major adverse impacts to soils through compaction and loss.

Based on the large number of acres with soil impacts in Alternative A and the larger number of acres affected by grazing (3,700), the adverse impacts on soil resources would not be significantly offset by the beneficial impacts of some of the projects described above and, along with continued ranching, would continue to present a long-term, adverse cumulative moderate to major impact on the soil resources within the park and beyond the park boundaries.

Type of Impact: Adverse
Duration of Impact: Long-term
Intensity of Impact: Moderate inside and major outside the Seashore
Cumulative Impact: Adverse, long-term moderate to major cumulative impacts to soils within the park and beyond park boundaries.

Impacts on Vegetation

The Seashore and northern district of GGNRA are known to support over 900 plant species. The project area can be divided into 10 broad vegetation classes, ranging from forests to grassland and dunes. Because non-native deer feed primarily on grasses and some forbs, they are found in highest numbers within 4 vegetation classes: riparian forests, coastal scrub, grasslands and pasture. To a lesser extent, they can be found in the other forested classes: Bishop pine, Douglas fir/coast redwood, hardwood, Monterey pine/Monterey cypress forests. Non-native deer are not found in the coastal dune or wetland/marsh vegetation classes. The following tables reflect the specific plant communities where each species of deer is currently found.

TABLE 7: VEGETATION COMMUNITIES USED BY FALLOW DEER AT PRNS (DATA BASED ON PRNS VEGETATION MAP DATA AND CURRENT PRNS FALLOW DEER RANGE DATA)

Plant Community	**Acres**	**% of Total Range**
Grassland	6259	28%
Coastal Scrub	5,683	25%
Douglas-fir/Redwood	5,530	24%
Hardwood Forest	2,177	10%
Riparian Forest/Shrubland	1,011	5%
Pasture	684	3%
Bishop Pine	489	2%
Unvegetated	341	1%
Other	476	2%
Total Acres	22,655	

TABLE 8. VEGETATION COMMUNITIES USED BY AXIS DEER AT PRNS (DATA BASED ON PRNS VEGETATION MAP DATA AND CURRENT PRNS FALLOW DEER RANGE DATA)

Plant Community	Acres	% of Total Range
Grassland	625	41%
Pasture	507	33%
Coastal Scrub	209	14%
Other Herbaceous	55	4%
Unvegetated	51	3%
Bishop Pine	41	3%
Hardwood Forest	22	1%
Riparian Forest/Shrubland	12	1%
Total Acres	1,523	100%

Analysis

Deer and other ungulates can cause a variety of impacts on vegetation. They consume vegetation, which can result in changes to physical structure, structural diversity, species composition and productivity in plant communities, as well as weed and nutrient dispersal. Deer can trample vegetation, particularly when they congregate in large groups, as they do during the rutting season or other times of the year at the Seashore. Deer can alter patterns of nutrient cycling both within plant communities and by transferring nutrients from one community to another, and can change the distribution of nutrients between plant shoot and root structures. Depending on the soil fertility, intensity of grazing and the vegetation being grazed, deer and other ungulates can stimulate or suppress vegetative productivity across a landscape.

Studies of the diets of fallow and axis deer at the Seashore have found that both species tend to eat grasses and some forbs in the fall, winter, and spring, and comparatively more forbs in the summer. The same studies found they ate more forbs and browse than cattle, and that native black-tailed deer ate mainly forbs throughout the year (Elliott and Barrett 1985; NPS unpublished data 1983; Elliott 1983). The diet of black-tailed deer overlapped with axis and fallow deer to some degree, particularly during the summer or during times of drought, when both ate forbs. A review of Elliott's 1982 dietary overlap study by Gary Fellers, a U.S. Geological Survey scientist, suggested that exotic deer at levels of 350 for each species could reduce the native black-tailed deer population size by up to 30% (Fellers 1983). If black-tailed deer numbers are strongly influenced by the energy content of their diet, the reduction in their population, when fallow deer number 350, could be as much as 40% below carrying capacity (Fellers 1983a, 1983b, 2006). Tule elk, another ungulate native to the Seashore area, were reintroduced to the park in 1978. The majority of tule elk are kept in a fenced area at Tomales Point, but a small group has been released into the remainder of the park. Studies of the diet of tule elk show that this species eats grasses year-round, particularly during the winter (Gogan and Barrett 1995). In the spring, they add considerably more forbs to their diet, and in summer, may add shrubs like willow.

A few species made up the bulk of fallow and axis deer diet. These are grasses *Danthonia californica* and of the genus *Agrostis* and *Bromus*, the forb *Plantago lanceolata*, and a legume *Lotus corniculatus* (Elliott and Barrett 1985). Black-tailed deer also consumed *Plantago* and *Bromus*. Other studies have characterized axis and fallow deer as primarily grazers, but opportunistic feeders that also eat shrubs, buds, shoots, and leaves of trees. They are classed as intermediate mixed grazers that can feed on a variety of shrub, understory, forb and grass species depending on availability (NSW Scientific Committee 2004).

A comparative study of tule elk and fallow deer diets in the Limantour and Tomales Point areas has shown that elk and fallow deer in the Limantour area use similar forage species throughout the year (Fallon-McKnight 2006). Fallow deer show a preference for native clovers (*Trifolium spp.*) and brome (*Bromus carinatus*) as well as *Plantago spp.* (a high energy and high protein forage). The author of this study concluded that, in areas where both species cohabit, competition for forbs likely remains throughout spring and summer, which is a time that both species are nursing young. Increased grazing pressure on *Plantago* spp. and other important forage items by fallow deer could deprive Limantour elk of the nutritional benefits of these food resources at a critical time and result in decreased female condition, juvenile survival, and ultimately, decreased recruitment.

The scientific literature is full of information about the effects grazing ungulates can have on vegetation, both in a particular forest or shrublands as well as across landscapes. In northern forests, where nutrients are often not readily available because they are tied up in slowly decomposing leaf and needle litter, selective grazing by deer can eliminate or retard the growth of young trees, shrubs and forbs, allowing grasses and unpalatable species to increase. Over time, and assuming browsing pressure is not high enough to eliminate all seedlings, deer bring about a change in the species composition of surviving seedlings and saplings. For example, in mixed hardwood forests monitored in one study, birch, alder and beech were resistant because they are unpalatable to deer while oak, ash and willows were vulnerable (U.K. Forestry Commission 2000). A similar study that modeled the effects of heavy white-tailed deer (*Odocoileus virginianus*) grazing on forests in Virginia found sapling recruitment of white ash and *Rubus* spp. saplings was suppressed 80–95% over control sites. Deer densities in that study were 30–40 deer/ sq. km. (Cross 1998) while deer densities in the Seashore can exceed 80 deer / sq. km. (NPS 2002a).

Grazing in woodlands can keep trees from reaching their full stature, or from becoming established at all. It can also reduce the height of shrubs, or nearly eliminate the shrub layer altogether (Putnam 1986). Axis and fallow deer eat some shrubs, but, during most of the year, primarily eat grasses and forbs. In riparian areas where fallow deer congregate in large herds of up to 150 animals, long-term browsing of forbs and grasses has led to a lack of understory vegetation (J. Rodgers, NPS, personal communication). This and an absent middle layer of shrub vegetation is not unusual where heavy grazing occurs, and can eliminate an important component of wildlife habitat, particularly for birds. On Moloka'i in the Hawaiian Islands, axis deer have created "browse lines" on standing vegetation, an obvious clearing of vegetation from the ground to the highest point the deer can reach (Dorman 1997).

Lighter grazing does not have this effect. One study of the effects of deer on mixed hardwood and deciduous forests in the U.K. found that densities below about 3–7 deer/ sq. km. allow regeneration of trees and shrubs (U.K. Forestry Commission 2000).

Heavy or sustained grazing in woodlands reduces species diversity. Although lighter grazing might leave some saplings, browse, and forbs in forests and actually result in increased species diversity, sustained heavy grazing eliminates virtually all individuals of palatable species, and can leave near monocultures of unpalatable species behind. For example, in England where fallow deer were introduced a thousand years ago by the Romans, moderate levels of grazing have resulted in the expansion and spread of holly, to the exclusion of forbs and browse. Grasses and rosette-style plants, which are able to withstand heavier grazing pressure, have also proliferated (Putnam 1986). In the Royal National Park in New South Wales, grazing by exotic Rusa deer (*Cervus timorensis)* have been shown to alter the structure, species abundance and composition of grassland communities. Areas with higher densities of deer show 30–70 % fewer plant species that those with lower densities. (New South Wales National Parks and Wildlife Service 2002; New South Wales Scientific Committee 2004) In Pennsylvania forests, variable densities of white-tailed deer were found to be linked with forest changes. Species richness and the height of saplings declined once density of deer exceeded 7–8 per sq. km., and seedlings of six species were missing altogether at these densities (deCalesta 1997).

Over time, heavy grazing of woodlands or shrublands can mean conversion to grassland dominated by unpalatable species. In grassland ecosystems, the natural progression to shrubland or forest is sometimes halted indefinitely by ungulate grazing (Putnam 1986; Deer Commission for Scotland 2004; Cross 1998). Fallow deer in England remove the tips of lateral and leading shoots of trees and shrubs, and would graze forbs and grasses to the point of creating a "lawn" only a few millimeters high and composed of a few grass species (Deer Commission for Scotland 2004). In some areas of the world, non-native ungulate grazing has devastated species richness and altered physical structures to the point that the forest no longer exists. In Hawaii, on the island of Moloka'i, very heavy grazing pressure from introduced axis deer on the Kalaupapa peninsula has resulted in landscape-scale adverse impacts on vegetation (Dorman 1997) On Lana'i, axis deer and feral pigs have stripped vegetation and eaten emergent plants of trees and shrubs to the point that they have converted the Ohia-Hapuu rainforest to a grassy scrubland (Dorman 1997).

Concern over the selective grazing by exotic Rusa deer on rare species or vegetation in unique vegetative communities has also prompted the National Parks System of New South Wales to declare them a "key threatening process" and a target for eradication under Australia's Threatened Species Conservation Act (NSW Scientific Committee 2004). The scientific committee making this finding listed the loss of 30% of the understory species in sandstone heath, 40% loss in sandstone woodland, and 70% loss in littoral rainforest. All three are protected and rare plant communities.

Recently, U.S. researchers, in a review of 63 past field studies conducted in a wide range of biomes, concluded that non-native ungulates (cattle, horses, exotic deer, sheep, etc.) selectively suppress the abundance of native plants in the field, promoting exotic plant dominance and richness (Parker et al. 2006). They hypothesized that non-native ungulates often originate in the same regions as the non-native plants and are co-adapted to them and therefore less able to limit their invasion or spread ("invasional meltdown" hypothesis).

In the Seashore, riparian areas account for 5–6% of the range occupied by fallow and axis deer but are used disproportionately by them. These are unique areas in the park, and offer habitat for a variety of wildlife species, some of them threatened or endangered. The Seashore is attempting to restore, with fencing, some of these riparian areas in the Olema Creek watershed that have been degraded by cattle. Park managers have been unsuccessful in keeping fallow deer out. In fact, fallow deer spend much of the rut season in these streamside forests and shrublands. Herds of up to 150 animals tend to remain faithful to certain pastures and woods and return to them frequently year-round (NPS unpublished data (j)). Densities can be as high as 80 deer/ sq. km., several times the densities at which the effects of heavy grazing have been documented for white tailed deer and other ungulates.

The effects of so many deer in a sensitive streamside habitat can be locally severe. Most small to mid-sized deer species are thought to consume 3–4% of their body weight in vegetation daily (Halls 1970). This means that, at a minimum, current non-native deer populations remove 1–2 tons of forage from the Seashore per day. Riparian vegetation is not extensive in the Seashore, and concentrating some portion of this consumption in it even for a short time would have highly noticeable effects. Because fallow deer return annually to these rutting ("lekking") areas, the effects could be wider in scope or be cumulative over time than if it were a single event. In addition to consuming vegetation, fallow deer damage and remove it through trampling, through breaking trails, and bucks through antler thrashing, digging or mating displays.

The impacts of such high densities have been increased denudation of areas, soil erosion, compaction of soils, destruction of understory and saplings and a reduced ability for vegetation to regrow. Where the park has fenced riparian areas to protect them from cattle grazing, revegetation efforts and natural regrowth have been severely retarded due to heavy grazing, girdling and antler rubbing by fallow deer

(PRNS unpublished data (i); Fellers and Osbourn 2006). In 2005, 64% of fallow deer lek sites exhibited shredded foliage, 45% exhibited trees with damaged bark and 19% exhibited exposed tree roots. Continual grazing of new shoots and seasonal thrashing by fallow deer can prevent native riparian plants from growing beyond shrub height. At one riparian restoration area in particular, John West Fork of Olema Creek, NPS staff has observed extensive damage to native willows (*Salix spp.)* in areas excluded from livestock access (B. Ketcham, NPS, personal communication). It has taken an unusually long time (5 years) since cattle exclusion for the willows to grow beyond waist height. Riparian restoration and planting projects conducted in wilderness and natural areas where densities of fallow deer are much lower (i.e., Muddy Hollow Culvert Restoration Site) have shown much more rapid vegetative recovery (NPS unpublished data (i)). Figures 13-16 illustrate fallow deer damage to riparian and woodland vegetation.

In addition to the effects deer have on the physical structure, species diversity and composition of vegetative communities, they can act as forces in the distribution of seeds and nutrients. For example, consumption of non-native seeds in one area and migration and dispersal into an unaffected area can add to the spread of invasive plants. This is true for native plants as well. Grazers can also exert a large-scale effect on the nutrient levels in soils through their waste products. While the high nitrogen content of urine may damage some species, others grow more quickly in nitrogen enriched soil. Feces and urine can stimulate soil microbial activity as well, which means the production of nitrogen is increased and available to plant roots. This is taken up by plant shoots and becomes available to herbivores as more nutrient rich forage (van derWal et al. 2004). The cycle of adding nutrients in the form of waste products and returning it in the form of more nutritious forage is one of the key mechanisms grazers manipulate their own food supply, particularly in grasslands, although the effect has been proven in tundra ecosystems as well (van derWal et al. 2004). Grazing or browsing can also stimulate carbon allocation to root systems. This increases microbial activity and stimulates the production of nitrogen, which in turn can increase productivity above ground. This cycle occurs readily in grassland ecosystems where grazing pressure is light, and can lead to a proliferation of grasses preferred by some ungulates (Wardle and Bardgett 2004).

Unmanaged and expanding populations of non-native deer would continue to impact vegetation communities throughout the Seashore. Non-native deer grazing, girdling and thrashing impacts would also reduce the success and effectiveness of plant conservation and restoration projects by affecting individual rare species as well as recovering native vegetation. Currently, the impacts of non-native deer to vegetation in the park remain localized and moderate. However, if Alternative A were implemented, herds would increase in size and the damage to vegetation would be more widespread inside the park. Over the 15-year lifetime of the plan, impacts inside the park would become moderate to locally major and would persist indefinitely or continue to worsen.

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests) exists in close proximity to PRNS, GGNRA, and throughout Marin and Sonoma Counties. The successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, adverse long-term impacts to the plant species described above could be substantial, highly noticeable, and could irreversibly change plant community size, continuity, or species richness and would therefore be characterized as major.

Unlike with livestock, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of non-native deer to vegetation communities.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As noted above, the Alternative A could have direct and indirect moderate to major adverse effects on vegetation. An assessment of cumulative impacts on vegetation considers the potential impacts that Alternative A may have on vegetation in conjunction with the impacts on this same set of vegetation resources from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for vegetation include:

- current dairy and beef ranching operations
- the Giacomini Wetlands restoration project
- Fire Management Plan implementation projects
- coastal dune restoration
- coastal watershed restoration (geomorphic sites) in Drakes Estero watershed
- Drakes Estero watershed restoration projects
- small restoration projects within the Seashore

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Current and future livestock grazing and dairying. Within the Seashore, livestock agriculture, as instructed by Congress in its Point Reyes Seashore implementing legislation, continues in the form of concentrated dairy and beef operations. Historically, heavy stocking rates had impacts on hydrology, aquatic habitat and water quality within the Seashore.

The NPS grants to individual ranchers Special Use Permits which describe the terms of the lease. The Permits may contain requirements to modify agricultural operations in order to reduce the adverse impacts of livestock concentration. Whereas ranching operations once occupied the entire Point Reyes Peninsula, only 25% of the area is now in agriculture and 75% is managed as natural lands or wilderness areas. Within the 28,000 acres leased for agriculture, livestock have been successfully excluded (through fencing and other strategies) from 7,000 acres with sensitive resources such as riparian zones and creeks. Stocking has also been reduced by approximately 50% from 12,045 head at the time of the park's establishment to 6,013 head at present. However, based on the park's Geographic Information Systems (GIS) analysis, it is estimated that approximately 3,700 acres of vegetation are degraded by cattle (D. Schirokauer, personal communication). These impacts to vegetation vary in intensity, depending on the area, from moderate to major.

Cumulative impacts to park vegetation also affected by non-native deer include the impacts of grazing by other wildlife, cattle grazing, logging and development, and fire management activities. Logging precedes the establishment of the Seashore, but has removed forest vegetation and increased erosion of soils. Tule elk feed on grasses and forbs similar to axis and fallow deer, and there is evidence that fallow deer and sympatric elk compete in the Limantour area for *Plantago* spp. (a high-energy and high-protein forage) (Fallon-McKnight 2006). Black-tailed deer eat a high percentage of forbs year-round (Elliott and Barrett 1985). To the degree that they eat the same types of forage during the same season as tule elk or black-tailed deer, grazing by non-native deer at the Seashore adds to any impact that vegetation may be experiencing from native ungulates or cattle, resulting in a minor adverse cumulative impact through consumption, trampling and the other factors identified above. However, to the extent that non-native deer displace native species and suppress their populations, this impact on vegetation (but not on native wildlife species themselves) is compensatory and not additive.

In some restored areas of the park, without the "clearing" effects of livestock grazing, shrub and forest communities are returning. Increased numbers of non-native deer, because they are primarily grazers, would reverse this shift and would likely return natural and wilderness landscapes back to open non-native grassland communities. Adverse impacts from axis and fallow deer would be additive to impacts caused by livestock in facilitating the invasion and spread of exotic plants, as suggested by recent research into the "invasional meltdown" hypothesis (Parker et. al. 2006).

In areas that are managed for agriculture, tools to exclude livestock from sensitive areas, such as riparian zones and creeks, have been implemented with great success; approximately nine miles of sensitive area exclusionary fencing has been built. Restricting access for non-native deer populations with fencing is impractical for anything other than small areas. Persistence of non-native deer would maintain concentration-associated adverse impacts (not found with native black-tailed deer) to vegetation in areas no longer managed for agriculture. Alternative A may also reduce the success and effectiveness of riparian restoration projects because of continued grazing and thrashing pressure by non-native deer.

Fire Management Plan. In areas treated with prescribed fire, minor, short-term adverse impacts associated with loss of vegetation, as well as the possibility of introduction or spread of non-native plants, would occur. However, the burns also would result in minor to moderate beneficial impacts as burning would stimulate growth of many native plant species, and would eliminate non-native vegetation.

Mechanical fuel reduction would have minor short-term adverse impacts on native vegetation through crushing or other physical impacts, but clearing of dense vegetation would have long-term, minor to moderate benefits on most plant communities as well. In light of observed consumption by non-native deer of rare bulb species after the 1995 Mount Vision fire, grazing pressure on *Fritillaria sp.* and other rare species in burned areas would likely increase after prescribed burns.

The selected fire management alternative will result in minor to moderate localized benefits to native vegetation from the removal of non-native Monterey pine and cypress trees. The selected alternative will have short-term, minor adverse impacts from unintentional burning of vegetation, especially in dry years. However, research and observations at the Seashore indicate wetland vegetation can be thinned and stimulated to reproduce by low or moderate intensity fires. These same fires can destroy non-native plants in wetlands. Minor to moderate short to long-term benefits to wetland vegetation from prescribed burning or even small wildfires are therefore possible.

Overall the fire management program would have short-term minor adverse effects, but long-term beneficial effects on vegetation.Coastal Watershed Restoration (Geomorphic Sites) in Drakes Estero Watershed, Drakes Estero Watershed Restoration Projects, Coastal Dune Restoration, Giacomini Wetlands Restoration, and Small Restoration Projects within the Seashore. These projects generally have short-term adverse impacts to vegetation and long-term beneficial impacts. The Giacomini and Coastal Dune Restoration projects will temporarily disturb a large number of acres (approximately 900), but the effects will benefit native vegetation by removing exotic plants and allowing regrowth of native species.

Based on the potential effects of Alternative A on vegetation and the adverse cumulative effects of some of the above projects, the adverse impacts on vegetation resources would be moderate to major. Cumulative impacts could be irreversible and substantial. Beneficial impacts of some of the above projects would not significantly offset the adverse impacts.

Conclusion

Based on data on current and past population growth of fallow and axis deer at PRNS, this alternative would result in an increase in non-native deer numbers within the Seashore and throughout Marin County. No impairment to vegetation would occur from implementing Alternative A. Based on current reports of direct damage to over 120 acres of riparian and understory vegetation within the Seashore, the magnitude of these impacts to vegetation within NPS boundaries is currently considered moderate in intensity (as defined in Assessment Methodology section, Impacts on Vegetation). However, under this alternative, the impact intensity to park vegetation is expected to increase over time to a locally major level because of increasing deer densities and increasing geographical scope of effects. Impacts outside the park would therefore be major in intensity. All impacts from this alternative to vegetation are adverse and long-term. The cumulative impacts of implementing Alternative A with the above described projects would be moderate to major and adverse.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate to locally major inside Seashore; major outside
Cumulative Impact:	Adverse, long-term moderate to major cumulative impacts to vegetation within the park and beyond park boundaries.

Impacts on Wildlife

The project area supports a wide diversity of wildlife species, including 28 species of reptiles and amphibians, 65 species of mammals, and uncounted invertebrates. Over 480 bird species (representing 45% of the avian fauna documented in the United States) have been sighted and approximately 100 species breed within the park. Wildlife can be impacted in a number of ways by non-native deer management. Directly, wild animals can be injured or killed during deer capture, monitoring or management operations. Indirectly, through destruction of habitat and competition for required resources, animals can be impacted by changes in the abundance and range of non-native deer.

Wild animals are dependent on a multitude of ecosystem elements, ranging from specific habitats for reproduction to specific trace dietary minerals for growth and maintenance. Some of the elements, which constitute an animal's "niche," are known to scientists, some have yet to be discovered. If two species utilize the same resource, scientists describe the finding as "niche overlap." Such a finding implies, but does not definitively prove, that increasing numbers of one of the overlapping species would negatively impact the other. An example of such an overlap is Elliott's finding that in times of low forage availability, such as during droughts or at the end of summer, both non-native deer species feed on many of the same browse plants as native black-tailed deer (Elliott 1982). At this time of year, when the energy and protein content of available forage is at its lowest, axis and fallow deer switch from eating primarily grass to eating forbs, non-grass like herbs that constitute the bulk of the black-tailed deer diet year-round. Fallow deer may also impact sympatric tule elk in the Limantour area in their foraging for forbs, grasses and especially, *Plantago* spp. (a high energy and high protein forage). (Fallon-McKnight, 2006). Competition between elk and fallow deer for forbs likely continues throughout spring and summer, which is a time that both species are nursing young. Increased grazing pressure on this and other important forage items by fallow deer could deprive Limantour elk of the nutritional benefits of these food resources at a critical time (Fallon-McKnight 2006).This would decrease survival of calves and result in reduced recruitment for the Limantour herd, which currently consists of 45 animals.

Evidence of niche overlap, as demonstrated in dietary overlap studies, cannot automatically be interpreted as competition between two species (Gogan and Barrett 1995; Feldhammer and Armstrong 1993; Litvaitis

et al. 1994). Conversely, lack of niche overlap does not necessarily rule out competition since competition for shared resources can force species to adopt different food or habitat preferences to avoid competitive conflict (Putman 1986). Scientists would require evidence that the overlapping resource, in this case forbs, was limited and not available in sufficient quantity to supply both species. Evidence of detrimental effects, such as decreased fawn recruitment in black-tailed deer or decreased survival of tule elk calves, would demonstrate that the overlap might be impacting one of the competing species. Intraspecific competition is notoriously difficult to demonstrate scientifically. In the absence of scientific evidence of competition between species in the context of evaluating impacts of non-native deer to wildlife, data collected from research elsewhere in the U.S. and abroad would be evaluated. In addition, degree of suspected niche overlap along with anecdotal and historical evidence and expert opinion would provide insights and guidance for the analysis.

Impacts to individual animals within a species would be considered in the context of pain and suffering caused by proposed actions to wildlife, specifically, non-native deer. All proposed alternatives include provisions to prevent unnecessary animal suffering (see Actions Common to All Alternatives). Recommendations for humane animal treatment developed by the American Veterinary Medical Association would be used for all alternatives. The American Veterinary Medical Association considers, in some circumstances, gunshot to be the only practical and acceptable method of euthanasia in wildlife, when delivered by personnel sufficiently skilled to be accurate and experienced in the proper and safe use of firearms (AVMA 2001). Because pain and suffering is not scientifically measurable in animals, it would be assessed for each alternative using best professional judgment of wildlife biologists, managers and veterinarians. Humaneness is a person's perception of harm or pain inflicted on an animal. The concept, a uniquely human construct, is complex and can be interpreted in a variety of ways (USDA 1997). Consequently, impacts to visitors of animal pain and suffering caused by project actions would be discussed in Impacts on Visitor Experience.

Analysis

For this analysis, the best professional judgment of wildlife biologists, as well as research completed at the Seashore and elsewhere, have been used to determine impacts of increasing fallow and axis deer populations and range on other wildlife species. In general, more non-native deer would constitute an increase in magnitude and scope, both within and outside the Seashore, of current impacts to other species that share limited resources.

Non-native Cervids

The larger population sizes and ranges, which would result from this alternative would clearly benefit both axis and fallow deer. Their ranges would increase both within and outside of NPS boundaries, into other parts of Marin County. Axis deer have occasionally been sighted as far east as Nicasio Reservoir (PRNS unpublished data (k)). Current fallow deer range maps suggest that fallow deer have spread recently towards the south and eastward borders of the Seashore and they have been observed as far east as Woodacre. Fallow deer in New Zealand have spread at rates of up to 4.5 miles per year (Mungall and Sheffield 1994). Favorable non-native deer habitat (interspersed grasslands and oak woodlands) exists in close proximity to PRNS, GGNRA and throughout Marin County. Fallow deer were successfully introduced to an area of grassland/oak woodlands in central Mendocino County in 1949 and have persisted there. Their numbers and range are apparently restricted by surrounding coniferous forests, chaparral, and hunting (Jurek 1977). The successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of the county is likely. Low levels of hunting in Marin suggest that population expansion might remain uncontrolled and irreversible[4].

[4] Fewer than 1% of all hunting licenses (type 110) sold in California in 1999 were purchased by Marin County residents (CDFG database, http://www.dfg.ca.gov/licensing/pdffiles/Reg_HuntingItems90s.pdf).

Expansion rates of non-native deer would depend on a number of factors beyond the control of NPS, namely, range conditions, and hunting pressure.

Impacts to non-native deer from Alternative A would be beneficial and long-term. Because the impacts have the potential to affect areas beyond Seashore boundaries and could be irreversible, impact intensity is considered major.

Native Cervids

In their study of axis and fallow deer introductions nationwide, Feldhammer et al. (1993) stated:

> "We may expect competition between exotic and native artiodactyls both intuitively, and on the basis of previous field experiments with a variety of animal groups from various trophic levels and habitats…"

Native black-tailed deer are primarily browsers while both axis and fallow deer have been shown to be grazers. However, studies at PRNS have demonstrated that, during times of low forage availability, non-native deer adapt their feeding habits and consume larger amounts of forbs and browse (Elliott 1983; Elliott and Barrett 1985). Higher numbers of non-native deer would result in increased competition with native black-tailed deer for forbs and browse during droughts, at the end of summer, and year-round on poor quality ranges (Connolly 1981; Elliott 1983; Fellers 1983). Fiercer competition for limited forage would result in diminished condition in black-tailed deer (Brunetti 1976; Fellers 1983). It has been repeatedly shown in the scientific literature that poor condition in adult female cervids results in decreased reproductive capacity (Verme 1962 and 1967; Thorne et al. 1976; Keech et al. 2000). Increased competition for forage would likely result in lowered black-tailed doe fertility, decreased fawn production and lower fawn survival over current levels. Fellers estimated that at current levels of non-native deer (approximately 250 axis and 860 fallow deer), for every 1-2 non-native deer in the Seashore, one black-tailed deer is lost (Fellers 2006). He also estimated that if non-native deer numbers increased to 1,500, there would be a 63% reduction in the black-tailed deer population. The magnitude of the impacts of Alternative A to black-tailed deer populations would depend on range conditions, precipitation patterns and non-native deer numbers but would be considered major and could be expected to last longer than two breeding cycles. It is important to note that impacts would occur throughout larger and larger areas of Marin as non-native deer range expanded in the future as a result of this alternative. Black-tailed deer are considered a "keystone " species in the native California coastal ecosystem because increases and decreases in their population numbers have repercussions throughout the park ecosystem. As noted above, units of the National Park Service are unable to allow park resources or values to become impaired, and NPS Management Policies (section 1.4.5) indicate an impairment of a resource is more likely when conservation of that resource is "key to the natural or cultural integrity of the park…."Given its status as a central or keystone species in the Seashore's ecosystem and the degree of impact non-native deer appear to exert on it, implementing Alternative A is likely to result in impairment of this park resource.

In addition to dietary overlap and competition, there may also be impacts to black-tailed deer related to habitat preferences of both it and non-native deer. Black-tailed deer prefer a mosaic of various-aged vegetation that provides woody cover, meadow and shrubby openings while non-native deer favor habitats containing >50% grassland (CDFG 1998; Elliott 1982). However, there is some interspecies habitat overlap during certain times of the day and seasonally. Black-tailed deer are thought to avoid large herds (consisting of more than 50 animals) of fallow and axis deer (NPS, PRNS unpublished data (l)). Alternative A would result in higher densities of non-native deer both within and outside of the Seashore. Consequently, native black-tailed deer would likely avoid high-density areas when non-native deer were present.

In addition to impacts on native deer, fallow and axis deer may adversely affect native elk populations at the Seashore. Biologists in New Zealand documented that established, high-density populations of fallow deer competitively excluded red deer (*Cervus elaphus scotticus*), an elk species native to Europe (Challies 1985). Red deer are considered the most widespread and successful of all deer species introduced to New Zealand except where their range overlaps with previously established fallow deer populations (Challies 1985). Increased densities of fallow deer in areas of the Seashore where free-ranging tule elk inhabit would likely inhibit expansion of the elk herd and may suppress elk numbers where the new free-ranging

subpopulations are not well established. These areas include the southwestern wilderness areas of the park south of Drake's Estero and west of Inverness ridge.

In addition to inhibiting further expansion of tule elk herds, higher numbers of non-native deer could adversely impact current elk populations in the Seashore through increased competition for forage (Brunetti 1976; Fallon-McKnight 2006). Deer are thought to consume 3% to 4% of their body weight in vegetation daily (Halls 1970). At a minimum, current non-native deer populations consume 1-2 tons of forage per day. As a result of Alternative A, this total forage intake would increase and a substantial amount of vegetation would become unavailable for native grazers. Increased consumption by non-native deer of highly nutritious forage would remove an important food source for pregnant and nursing cows (Fallon-McKnight 2006). Such impacts would be reflected in lower elk calving rates, delayed onset of reproduction in tule elk cows and reduced elk calf survival.

Direct behavioral competition between fallow deer and tule elk currently exists at PRNS and would likely increase with Alternative A. Researchers in the Zehusice Deer Park in the Czech Republic have documented behavioral exclusion of red deer by fallow deer at high-density feeding sites (Bartos et al. 1996). Fallow deer at Zehusice were observed to: (1) be consistently more aggressive than red deer, (2) preferentially seek out feeding sites where red deer congregated, and (3) attack red deer from the rear as a strategy to overcome their larger opponents (Bartos 1996). In the Tomales Point Elk Reserve at PRNS, fallow bucks have been observed sparring with tule elk bulls (PRNS unpublished data (m)). In all observed instances, fallow bucks were successful in chasing away elk bulls in spite of a substantial size disadvantage. The consequences of increased behavioral competition are difficult to predict with certainty but could include exclusion of elk from higher quality forage or habitat, decreased condition of reproducing adults and ultimately, decreased population growth or population decline.

Paratuberculosis, or Johne's disease, is an infectious and incurable diarrheal wasting disease of wild and domestic ungulates. In a study conducted at PRNS in 1979, paratuberculosis was documented in 9.6% and 8.1% of axis and fallow deer, respectively (Riemann et al. 1979b). Johne's disease was confirmed in a PRNS axis deer as recently as 2000 (NPS unpublished data (g)). The disease has been documented in tule elk at Tomales Point Elk Reserve since 1980 (Jessup et al. 1981). In spite of their known susceptibility to the disease, and the 1999 testing of 120 Seashore black-tailed deer, deer have not been documented to carry paratuberculosis in PRNS (Williams et al. 1983; Sansome 1999 unpublished report). Over 120 black-tailed deer at PRNS have been tested for Johne's disease and it is possible that the disease causes rapid death in this species, thus precluding its diagnosis in randomly sampled deer (E. Manning, Johne's Testing Center, personal communication). In 1998, relocation of 45 adult tule elk from Tomales Point to the Limantour wilderness area included a 6-month quarantine and extensive testing for Johne's disease (Manning et al. 2003). Only those animals that consistently tested negative on all blood tests and fecal cultures were released in July 1999 to form a new free-ranging herd. This elk herd is currently made up of 45 animals. The goal of the relocation is to restore the dominant native herbivore to the Seashore's wilderness ecosystems.

Transmission of the organism that causes paratuberculosis (*Mycobacterium avium ss. paratuberculosis*) occurs primarily from infected adults to young animals. The period of greatest susceptibility for this infection appears to be the first 6 months of life. The organism is shed by infected animals into feces that may contaminate feed, water, and pastures. The prevalence of the infection and the incidence of clinical disease may climb when an affected population approaches carrying capacity. At these high densities, affected herds experience the stressors of reduced forage nutritional quality and reduced ability to fight disease. This immunosuppression can result in increased transmission of infection and progression to clinical illness as well as heavier parasite loads. (Manning et al. 2003). Animals in the clinical phase of Johne's disease shed the organism more often and in greater numbers. Premise contamination with this

hardy and long-lived organism may thus increase, a factor relevant to the health of numerous species. All cervids are believed to be susceptible to this infection (Manning and Collins 2001).

Alternative A would result in higher densities of non-native deer in PRNS and outside of NPS boundaries, with populations of axis and fallow deer eventually reaching carrying capacity. Because non-native deer congregate in large herds, the prevalence of paratuberculosis would rise in these herds and the potential for transmission to the tule elk and black-tailed deer that share their habitat would increase. Exposed elk or deer, infected as juveniles, would spread the disease to their offspring. As has been observed at Tomales Point, infection would result in diarrhea, weight loss, lowered reproductive capacity and eventual death of individual deer. On a population level, introduction of paratuberculosis into the free-ranging tule elk herd could result in slower growth of the population. Black-tailed deer may be more susceptible than other species to natural infection and rapid onset of the disease (Williams et al. 1983). Transmission, should it occur, would adversely impact juvenile survivability and, in cases where large numbers of black-tailed deer were exposed, would cause eventual decline of native deer numbers.

Newly discovered ectoparasites, on fallow and axis deer pose an unknown but potentially significant risk of disease to native black-tailed deer and tule elk. In 2005, USDA researchers discovered 2 species of chewing lice on PRNS fallow deer and 1 species of chewing lice louse on PRNS axis deer (National Veterinary Services Laboratories communications). Of most concern was *Bovicola tibialis*, a chewing louse typical of fallow deer, but not native to either black-tailed deer or tule elk. USDA researchers are concerned that this parasite may transfer from fallow deer to native cervids and cause the disease pediculosis. Transfer of *B. tibialis* from fallow deer to black-tailed deer has been documented elsewhere in California and in Canada (Bildfell et al. 2004; Westrom et al. 1976). Disease resulting from the inter-species transfer of both chewing and sucking lice to cervids has been well documented in the literature (Brunetti et al. 1971; Foreyt et al. 1986; Westrom 1976; Bildfell et al. 2004). Pediculosis, or infestation with lice, causes alopecia, loss of body condition, and death in a variety of wildlife species (Bornstein et al. 2001). The more serious pediculosis outbreaks are generally associated with the exposure of a previously unexposed population to a new or exotic parasite. USDA researchers and NPS managers are concerned that clinical disease resulting from transfer of any non-native lice to native deer could cause increased morbidity, mortality and reduced recruitment of young. Alternative A would result in higher densities of non-native deer in PRNS and outside of NPS boundaries. As with Johne's disease, the prevalence of pediculosis would rise in these herds and the potential for transmission to the tule elk and black-tailed deer that share their habitat would increase.

Genetic variability assists populations in adapting to environmental changes and reduces vulnerability to catastrophic events such as disease, abnormal weather cycles, pollution etc. Fewer than 4,000 of the 500,000 tule elk historically present in California, currently remain. Tule elk at PRNS have passed through at least four severe population reductions or “bottlenecks”. With each bottleneck, the amount of genetic variability in the population has been reduced. It has been estimated that PRNS elk are among the most inbred in California, with a degree of relatedness equivalent to that resulting from three consecutive brother-sister matings (McCullough et al. 1996). Physical signs of inbreeding, such as cleft palate, have been observed in the Tomales Point herd (Gogan and Jessup 1985).

Management techniques to increase genetic diversity within and among wildlife populations include: (1) translocating animals between subpopulations, and (2) increasing the number of reproducing animals within each subpopulation (McCullough et al. 1996). For the past 5 years, NPS has cooperated with California Department of Fish and Game to transfer adult elk cows to Tomales Point, in order to increase genetic variability. One of the primary goals of the PRNS General Management Plan is to maintain viable populations of tule elk in the Seashore and to restore free-ranging elk to wilderness ecosystems. Alternative A would likely slow the growth of tule elk numbers required to increase genetic variability in the Limantour elk herd. Increased competition for resources with fallow deer and potential transmission

of paratuberculosis could hobble herd growth. Smaller numbers of breeding animals would result in lower genetic variability and increased risk of catastrophic population downswings.

Alternative A would result in:

- decreased tule elk and black-tailed deer food availability;
- slowed growth or reduction of tule elk and black-tailed deer numbers;
- decreased tule elk range; and
- reduced potential for increased genetic variability within a the PRNS tule elk population.

Impacts to native cervids from Alternative A inside and outside of NPS boundaries would be adverse, moderate to major, depending on the species, and long-term. Major impacts to native black-tailed deer would be severe enough that an impairment of this park resource is likely to result from implementing this alternative.

Small Mammals

The impacts of increased non-native deer populations on small mammals would occur in two ways: (1) by beneficial or adverse habitat alteration, influencing food supply, and cover; and (2) by direct, adverse competition for resources, mainly, food (Flowerdew and Ellwood 2001). In order to definitively demonstrate impacts of growing deer populations on small mammals at PRNS, large-scale deer exclosure experiments would have to be used to investigate responses at varied deer densities. Impacts to small mammals are extrapolated from research completed in the U.S. and in the U.K. on fallow deer and white-tailed deer in lowland woodlands (Putman 1986; McShea 2000; Flowerdew and Ellwood 2001; Fuller 2001). Inventories of small terrestrial vertebrates, conducted at PRNS from 1998-2001 in agricultural and ungrazed areas of the Seashore, were also considered in this analysis (Fellers and Pratt 2001).

In the Britain, heavy grazing pressure (100 deer/sq. km.) by fallow deer in lowland forests caused reductions and even local extirpations of wood mice, bank voles and common shrews (Putman et al. 1989). The loss of palatable ground-level vegetation removes food sources for small herbivores and at the same time, changes microclimates and reduces protection from predators (Flowerdew and Ellwood 2001). Increased browsing of shrubs in forested habitat or on forest-grassland interfaces, as has been demonstrated in both axis and fallow deer at the end of summer and during droughts (Elliott 1982), would alter suitability of those areas for some species. Oak woodlands and riparian areas contain the most wildlife species of any habitat in California. Heavy or sustained grazing in woodlands reduces species diversity. High densities of fallow deer year-round as well as fallow bucks during the breeding season have been observed to alter woodland and riparian cover and vegetation at PRNS through browsing and antler thrashing (Fellers and Osbourn 2006; B. Ketcham, NPS, personal communication). Such high-density impacts would decrease cover and habitat for the dusky-footed woodrat (*Neotoma fuscipes*).

Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). Densities of fallow deer in the Olema Valley areas of PRNS currently approach 80 deer/ sq. km. (NPS 2002a) and could be expected to increase in Alternative A. Grazing pressure from non-native deer in many Olema Valley sites is currently considered heavy. Should this grazing pressure continue or increase with Alternative A, species that could be adversely affected are the: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*). Increased fallow deer densities and range resulting from Alternative A would likely reduce habitat for these species in limited areas of the Seashore and

throughout Marin County, for longer than 2 breeding cycles. The adverse impacts could therefore be considered moderate and long-term.

Not all species decline with increasing deer grazing pressure. Grazing at intermediate and low deer densities has been shown to increase or have no effect on some plant and animal species in Britain (Fuller and Gill 2001). At PRNS, deer mice (*Peromyscus maniculatus*) were found more often in pastures grazed by cattle than in pastures where cattle were excluded (Fellers and Pratt 2002). It is possible that with increased deer grazing pressure in PRNS, deer mouse abundance would increase. The Valley pocket gopher (*Thomomys bottae*), another small mammal species that thrives in open grassland environments, could also remain unaffected or increase.

Direct competition for food between non-native deer and small mammals is a potential adverse impact resulting from Alternative A. As stated before, definitive documentation of competition would require exclosure experiments. In the absence of such experimentation, evidence of dietary overlap between species has been evaluated. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996; Jurek 1977). In addition, analyses of fallow and axis rumen and fecal samples have shown heavy use of many of the same species used by small mammals (Elliott 1982; Fallon-McKnight 2006). Small mammals likely to be adversely affected by increasing competition for food are the: Pacific jumping mouse (*Zapus trinotatus*), California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus)*, western harvest mouse (*Reithrodontomys megalotis*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*).

Depending on local deer densities, weather patterns and the yearly mast crop, adverse impacts to small mammals from Alternative A range from minor to moderate throughout the Seashore and Marin County. Because they persist for longer than 2 breeding cycles, impacts are considered long-term.

Mammalian and Avian Predators

This category includes wildlife species, such as mountain lions (*Felis concolor*), coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), badgers (*Taxidea taxus*), weasels (*Mustela spp.*), and the raptors that prey on small mammals.

Although no research at PRNS has been conducted to document the extent to which non-native deer are preyed upon by carnivores, anecdotal and historical evidence suggest low-level predation, especially on fawns. Since their introduction in the 1940s, there has been a decrease in the proportion of observed white fallow deer, from 75% to 21%, suggesting that white individuals may be preferentially selected by predators (Wehausen 1973; NPS 2002a). An anecdotal report exists of an axis doe defending her fawn from a bobcat (NPS unpublished data (n)). Ranchers have reported coyotes preying on axis fawns in the pastoral zone (N. Gates, NPS, personal communication). However, because non-native deer congregate in large groups and prefer open habitat, it is unlikely that they serve as a primary prey base for native mega- and meso-carnivores, which specialize on stalking black-tailed deer and small mammals. Alternative A would increase the prey base for mountain lions, coyotes and bobcats. This beneficial impact would likely be offset by a decrease in both the black-tailed deer and small mammal prey base for these carnivores, foxes, weasels and badgers.

In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls (*Strix aluco*) and kestrels (*Falco tinnunculus*), especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely adverse impact on their rodent prey base, Alternative A would have an adverse impact on birds of prey such as great-horned owls (*Bubo virginianus*), short-eared owls (*Asio otus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), red-shouldered hawks (*Buteo*

lineatus), red-tailed hawks (*Buteo jamaicensis*), Northern harriers (*Circus cyaneus*), black-shouldered kites (*Elanus caeruleus*), sharp-shinned hawks (*Accipiter striatus*) and Cooper's hawks (*Accipiter cooperii*).

Overall, the adverse impacts of Alternative to predators in the Seashore and in Marin County would be moderate and long-term.

Other Birds

Little is known about the impacts of grazing wildlife on birds in the Seashore. In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle and in ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Only one species, the savannah sparrow (*Passerculus sandwichensis*), was found in higher numbers in grazed grasslands.
Deer exclosure studies in Pennsylvania hardwood forests indicate that high densities of white-tailed deer (*Odocoileus virginianus*) cause declines in intermediate canopy-nesting songbirds. This study showed complete absence of certain songbird species, including American robins (*Turdus migratorius*), at deer densities over 25 deer/ sq. km. (deCalesta 1994). These declines are thought to occur because high deer numbers alter the structure of woody and herbaceous vegetation 0.5 - 7.5 meters above the ground (deCalesta 1994). Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests suggested that some bird species, namely understory nesters, declined with high deer grazing pressure while other species, namely bark foragers, benefited from reductions in understory vegetation. Researchers in British lowland forests determined that "losers" substantially outnumbered "winners" and that breeding populations of migrant birds were especially vulnerable to adverse impacts from heavy deer grazing pressure (Fuller 2001).

Table 9 lists the ground or low nesting bird species (nesting at approximately 0.3–3 meters) found in the Seashore. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). Impacts to the species listed would likely occur in a manner similar to the Pennsylvania study (deCalesta 1994). That is, there would be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. Impacts on reproductive success and survival are unknown. It should be noted that Table 9 primarily contains species breeding at PRNS and GGNRA and is not exhaustive. Three species that would likely be impacted, the San Francisco common yellowthroat (*Geothlypis trichas sinuosa*), the northern harrier (*Circus cyaneus*) and the California Swainson's thrush (*Catharus ustulatus oedicus*) are not listed in this table because they are either California Bird Species of Special Concern (CDFG) or Birds of Conservation Concern (USFWS) and are discussed in the section on Impacts on Species and Habitats of Management Concern.

TABLE 9: BIRD SPECIES LIKELY TO BE ADVERSELY IMPACTED BY ALTERNATIVE A (T. GARDALI, POINT REYES BIRD OBSERVATORY, PERSONAL COMMUNICATION, SHUFORD AND GARDALI, IN REVIEW)

Common Name	**Scientific Name**
Allen's hummingbird	*Selasphorus sasin*
American goldfinch	*Carduelis tristis*
Bewick's wren	*Thryomanes bewickii*
Brewer's blackbird	*Euphagus cyanocephalus*
California towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Marsh wren	*Cistothorus palustris*
MacGillivray's warbler	*Oporornis tolmiei*
Orange-crowned warbler	*Vermivora celata*
Oregon junco	*Junco hyemalis thurberi*
Red-winged blackbird	*Agelaius phoeniceus*
Spotted towhee	*Pipilo maculatus*
Western meadowlark	*Sturnella neglecta*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*

In increasing areas of PRNS, GGNRA and Marin County, it is expected that overall avian species richness, abundance and diversity would decrease measurably with the heavy grazing pressure resulting from Alternative A. Beneficial impacts to a few grassland species would be offset by larger adverse impacts to relatively more species that depend on understory shrub layers for nesting, especially in impacted riparian and woody-grassland interfaces. The adverse impacts to various species would be moderate and long-term within and outside NPS boundaries.

Reptiles and Amphibians

Some information is available on the impacts of large herds of grazing herbivores on reptiles and amphibians in the Seashore. During inventories of small vertebrates conducted at PRNS in 2001, northern alligator lizards (*Gerrhonotus coeruleus*) were not found in pastures grazed by cattle but were found in similar ungrazed sites (Fellers and Pratt 2002). Changes to woodland understory vegetation, especially in riparian areas, and grassland cover, as has been documented with high densities of fallow deer at PRNS, would alter microclimates and habitats for frogs, lizards and salamanders. Adverse impacts could be expected for: alligator lizards, California slender salamanders (*Batrachoseps attenuatus*), rubber boas (*Charina bottae*), western skinks (*Eumeces skiltonianus*), racers (*Coluber constrictor*), garter snakes (*Thamnophis elegans)*, and Ensatina salamanders (*Ensatina eschscholtzii*).

Because of expected minor to moderate adverse impacts of Alternative A on small mammal abundance (see above), concomitant decreases can be expected in reptiles that prey on shrews and rodents. Species in this category are the: western terrestrial garter snake, rubber boa, and gopher snake (*Pituophis melanoleucus*).

Studies of British lowland forests heavily grazed by fallow deer have shown that as a result of decreasing rodent numbers, kestrels relied preyed more heavily on lizards (Putman 1986). Inside and outside the Seashore, similar increases in predation by raptors and owls on lizards, frogs and snakes is likely to occur in areas of high non-native deer density.

Impacts to amphibians and reptiles in PRNS and throughout Marin County with Alternative A are expected to be adverse to a number of species. The impacts are moderate and long-term.

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests) exists in close proximity to PRNS, GGNRA and throughout Marin and Sonoma Counties. The successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, adverse long-term impacts to the wildlife species described above could be substantial, highly noticeable, measurable, and potentially irreversible. The intensity of such impacts could therefore be characterized as major.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As detailed above, the Alternative A could have direct and indirect moderate to major adverse effects on the wildlife. An assessment of cumulative impacts on wildlife considers the potential impacts that Alternative A may have on wildlife in conjunction with the impacts on this same set of wildlife resources from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for wildlife include:

- Tule elk Management Plan
- current and future livestock grazing and dairying
- the Giacomini Wetlands restoration project
- Fire Management Plan implementation projects
- coastal watershed restoration (geomorphic sites) in Drakes Estero watershed
- Drakes Estero watershed restoration projects
- Tomales Bay marine station
- Pacific Coast Learning Center
- small restoration projects within the Seashore

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Statewide deer estimates, which include all native subspecies of black-tailed deer, compiled by the California Department of Fish and Game (CDFG), suggest that deer numbers have decreased from record highs in the 1950s and 1960s. At that time, the population was estimated to be between 700,000-1,000,000; populations in late 1990s were estimated at 400,000-700,000. This decline is thought to have occurred because of declining deer habitat quality as a result of urbanization, fire suppression and changes in logging (CDFG 1998). Alternative A, along with these activities, would result in cumulative major adverse impacts to native black-tailed deer.

Sudden oak death, a fungal-type disease that kills tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and black oaks (*Quercus kelloggii*), was first discovered in 1995. Since then it has been documented in 12 California counties including Marin and was isolated in the Seashore in 2004 (A. Wickland, University of California, Davis, personal communication). The disease causes oak death and the loss of acorn crops, an important food source for many small native mammals and native deer. Non-native wild turkeys, which have existed in Marin County since their release by the California Department of Fish and Game in the 1970s, also feed on acorns. This species has been observed in western Marin and inside the PRNS boundaries (PRNS unpublished data (o)). The combination of feeding by this non-native species and loss of mast due to sudden oak death has and would continue to have combined (e.g., cumulative) moderate adverse impacts with feeding by non-native deer on wildlife that depend on acorns under Alternative A.

Current and future livestock grazing and dairying. Within the Seashore, livestock agriculture, as instructed by Congress in its Point Reyes Seashore implementing legislation, continues in the form of concentrated dairy and beef operations. The NPS grants to individual ranchers Special Use Permits which describe the terms of the lease. The Permits may contain requirements to modify agricultural operations so as to reduce the adverse impacts of livestock concentration. Whereas ranching operations once occupied the entire Point Reyes Peninsula, only 25% of the area is now in agriculture with 75% managed as natural lands or wilderness areas. Stocking rates have also been reduced by approximately 50% from 12,045 head at the time of the park's establishment to 6,013 head at present.

Agricultural practices (livestock grazing, silage production, manure spreading) can have adverse cumulative impacts to wildlife diversity and richness, with intensity of the impacts related to the timing, location and intensity of the practice. Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). The following species would be expected to decrease as a result of heavy livestock grazing: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*) (Fellers, USGS, personal communication). In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle and in ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Alternative A, when viewed incrementally with agricultural practices, would result in adverse cumulative impacts to wildlife, with intensities ranging from moderate to major.

Tule Elk Management Plan. The management of tule elk in Point Reyes National Seashore, as outlined in the 1998 *Tule Elk Management Plan Environmental Assessment*, will have beneficial impacts by contributing towards restoration of fauna to native ecosystems; by protecting habitats for endangered, threatened, and rare species; and by preventing impacts of elk overpopulation that could threaten biological diversity in native habitats.

Fire Management Plan. Some wildfire suppression activities or actions to control prescribed burns, such as spike camps, access or creating fire lines, would have minor short-term adverse impacts on wildlife. Other activities, such as creating helispots or the use of helicopter buckets of water or retardants, may have longer lasting adverse impacts. Overall, these activities are not expected to have more than minor adverse impacts to wildlife.

Treatment with prescribed fire and through mechanical means in the selected alternative would result in short to long-term, minor to moderate benefits to wildlife from the reestablishment of the natural fire cycle, reduction of fuel loads, and reduction of the potential for catastrophic wildfire. In the context of the entire study area, the FMP would result in minor short to long-term benefits to wildlife from creating open habitat.

Coastal Watershed Restoration (Geomorphic Sites) in Drakes Estero Watershed, Drakes Estero Watershed Restoration Projects, Coastal Dune Restoration, Giacomini Wetlands Restoration, Sewage System Improvements, and Small Restoration Projects within the Seashore. These projects generally have short-term adverse impacts to wildlife, but long-term minor to moderate beneficial impacts. The Giacomini and Coastal Dune Restoration projects will temporarily disturb a large number of acres (approximately 900), but the long-term effects will be beneficial to vegetation.

Tomales Bay Marine Station Rehabilitation and Pacific Coast Learning Center Rehabilitation. These two projects have an indirect minor beneficial effect on wildlife because they provide housing and office space for researchers to conduct ecological studies. The new information can guide park managers in making future decisions on wildlife management.

Overall, Alternative A, combined with the above projects and issues described, will have a long-term moderate to major cumulative adverse impact on wildlife. The effects would not be significantly offset by the beneficial impacts of any of the above projects.

Conclusion

Data on current and past population growth of fallow and axis deer at PRNS indicate that this alternative would result in an increase in non-native deer numbers within the Seashore and throughout Marin County. Adverse impacts of No Action to native ungulates, particularly native black-tailed deer, would be major. Black-tailed deer are considered a "keystone" species in the native California coastal ecosystem because increases and decreases in their population numbers have repercussions throughout the park ecosystem. Alternative A therefore affects a resource that is key to the natural integrity of the park or to opportunities for enjoyment of a park and as such, has potential to result in impairment. Based on research on impacts of non-native deer to wildlife in other countries as well as known impacts of grazing by cattle and white-tailed deer in the U.S., the impacts of Alternative A are expected to be beneficial to a few native species and adverse to a larger number of native species. Overall, moderate to major adverse impacts to native ungulates, moderate impacts to predators, birds and amphibians and reptiles, and minor to moderate impacts to small mammals inside the park are likely. Pockets of extremely high non-native deer density, such as those currently seen in Olema Valley, are likely to be found increasingly throughout Marin County. Native species richness and diversity would likely decrease in those high-density areas. Overall, the magnitude of impacts to native wildlife within NPS boundaries are considered moderate to major in intensity, adverse and long-term, and those outside the boundary have the potential to become major in intensity. The cumulative impacts of Alternative A with other projects and issues described would range from moderate to major and would all be adverse.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate to major inside Seashore; potential to become major outside the Seashore; impairment of Seashore black-tailed deer population is likely.
Cumulative Impact:	Adverse, long-term moderate to major cumulative impacts to wildlife within the park and beyond park boundaries.

Impacts on Species and Habitats of Management Concern

Analysis

Special Status Species

This category includes federally listed wildlife species. Other species of concern recognized by the state of California or Birds of Conservation Concern (USFWS) include several species of nesting land birds and raptors. The project area supports 47 listed animal species; 14 of these have federal status as endangered, 8 as threatened and 24 as species of concern. Nineteen federally listed plant species (seven of which are also state listed) and an additional 25 listed or proposed for listing by the California Native Plant Society have been documented in the project area.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect federally and state listed species, anecdotal, historical evidence and expert opinion can provide insights and guidance. The federally listed species that are likely to be affected by non-native deer include northern spotted owls (*Strix occidentalis caurina*), western snowy plover (*Charadrius alexandrinus nivosus*), California red-legged frog (*Rana aurora draytonii*), Coho and Chinook salmon (*Oncorhynchus kisutch and Oncorhynchus tshawytscha*), steelhead trout (*Oncorynchus mykiss*), California freshwater shrimp (*Syncaris pacifica*), and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

Northern Spotted Owl

The northern spotted owl is a federally threatened species that reaches the southern limit of its range within GGNRA, PRNS and Muir Woods National Monument in Marin County, California. Data collected by the NPS indicates that these parks may support the highest density of spotted owls known. However, the population is geographically isolated and subject to unique threats including urban development, intense recreational pressure, habituation of owls to humans, potential for catastrophic wildfires, and changes in hazardous fuel management practices. Owls occur throughout the forested lands in the Seashore and the population is likely stable; however, owls have been monitored for only 7 years in the Seashore (NPS and Point Reyes Bird Observatory unpublished data). Owls prey almost exclusively on small mammals, particularly dusky-footed wood rats (*Neotoma fuscipes*) in the Seashore (Chow 1998). Woodrats, in turn, are dependent on roots, stems, leaves, seeds and mast (Linsdale and Tevis 1951; Willy 1992).

Fallow deer have been recorded in areas where spotted owls nest and roost. To date, no direct effects have been noted on the productivity or survival of owls. However, deer compete with the prey species of owls, and therefore, likely have an indirect negative impact on food resources. By biting off buds and flowers they reduce the amount of seed and fruit available in autumn and winter. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996; Jurek 1977). In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls and kestrels, especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely minor adverse impact on rodent prey base due to competition for forage, Alternative A would have an indirect, minor, adverse impact on northern spotted owls. Overall, the adverse impacts of Alternative A to owls in the Seashore and in Marin County would be minor and long-term.

Western Snowy Plover

Western snowy plovers, federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS), nest along the sandy beaches of the Seashore, primarily on Point Reyes Beach between North Beach and Kehoe Beach. Historically, plovers also nested at South Beach, Drakes Beach and Limantour. Plover nesting success has increased slightly over the past few years due to intensive management by the Seashore; however, the species is vulnerable to numerous activities in the park including predation by ravens and disturbance by recreationists. Fewer than 20 chicks fledged in 2004 (Peterlein 2004). Cattle roaming on the beaches in the past were a potential source for disturbance; however, the Seashore now intensively restricts cattle from beaches. A large herd of 60 axis deer has been seen on South Beach within the last five years, and where the herd occurred, the ground was heavily impacted (S. Allen, NPS personal communication). The frequency of this activity by axis deer is unknown but likely does not occur with regularity. Consequently, the overall adverse impact of Alternative A to plovers in the Seashore is likely minor, depending upon whether plovers nest again at South Beach or whether axis deer expand onto the North Beach to Kehoe Beach area.

California Red-legged Frog

The California red-legged frog is federally listed as a Threatened species. Red-legged frogs breed in ponds or pools during the wet season (December through March), and use ponds and/or riparian habitats during the rest of the year. Fallow deer regularly frequent riparian areas and vigorously rub and thrash their antlers during the rut, resulting in maiming and destruction of riparian vegetation (Fellers and Osbourn 2006). While engaged in this activity, fallow deer cause extensive trailing and may trample frogs. Damage to the vegetation could lead to degradation of non-breeding habitat. Overall, the adverse impacts of Alternative A to frogs in the Seashore and in Marin County would be minor and long-term.

Coho Salmon, Steelhead Trout, and Chinook Salmon

Anadromous fish, listed as endangered and threatened by the National Marine Fisheries Service (NOAA Fisheries), occur in many of the streams of the Seashore, particularly in Olema Creek and Lagunitas Creek

The Seashore contains 10% of the last remaining wild population of coho salmon within the Central California Coast Evolutionarily Significant Unit, and consequently, any loss of this population would have an impact on the evolutionary significant unit. The NPS, along with the NOAA Fisheries and the CDFG, have conducted intensive fish surveys and have funded and implemented numerous restoration projects along the streams that flow through the park and adjacent lands. Numerous culverts have been removed along with other blockages to fish passage. In addition, the agencies have installed fencing to restrict cattle from riparian areas. These fences, however, do not impede the movement of fallow deer.

Fallow deer regularly frequent riparian areas and damage the riparian vegetation, particularly during the rut when bucks thrash branches and leaves with their antlers and girdle small trees and saplings (Fellers and Osbourn 2006). While engaged in this activity, fallow deer indirectly affect coho, steelhead and Chinook by damaging riparian plants, resulting in: increased erosion and sediment delivery to the stream, reduced cover, and potentially warmer water in streams due to exposure to sunlight. Increased numbers of fallow deer would increase the scope and intensity of this impact to riparian vegetation. In addition, an unmanaged and expanding population of non-native deer would reduce the success and potential effectiveness of riparian restoration projects for salmon due to grazing and thrashing pressure on recovering native riparian vegetation. In restoration areas, revegetation efforts and natural regrowth would be severely retarded due to heavy grazing, trailing and antler thrashing. Different from browsing where

leaves are plucked from a stem, this constant grazing and thrashing would prevent native riparian plants from growing beyond shrub height. In riparian areas where large numbers of fallow deer congregate or travel, fish redds could be trampled, adversely impacting reproduction in all 3 species. Overall, the adverse impacts of Alternative A to anadromous fish in the Seashore and in Marin County would be minor and long-term.

California Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is listed by the USFWS as Endangered. The shrimp inhabits lower Lagunitas Creek and lower Olema Creek, within the current fallow deer range at PRNS. Shrimp are highly dependent on overhanging riparian vegetation, under which they live year-round. Fallow deer have not been observed within known shrimp habitat. However, in other areas of both Lagunitas and Olema Creeks, which are potential future locations for this species, high densities of fallow deer have been observed to browse and trample riparian vegetation (Fellers and Osbourn 2006). An increase in fallow deer range, resulting from Alternative A would likely cause degradation of shrimp habitat with negligible to minor adverse impacts.

Myrtle's Silverspot Butterfly

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) is one of three coastal subspecies of *S. zerene* in the Western United States. The USFWS listed the subspecies as Endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992).

As of 1998, three populations are known to remain. The USFWS Myrtle's Silverspot Butterfly Recovery Plan (1998) estimated the three populations combined comprise 10,000 individuals. Two populations of Myrtle's silverspot butterfly occur within the Seashore and the third is on private land in northern Marin County. The Center for Conservation Biology at Stanford monitored distribution and abundance of the Myrtle's silverspot butterfly at Point Reyes National Seashore almost yearly from 1992 to 1998. The Stanford survey work shows a decline in Myrtle's silverspot butterfly population levels during the six-year period and the central population to be "barely existing" (Launer et al.1998). Grazing is believed to deplete the Myrtle's silverspot butterfly larval host plants. The Seashore is currently supporting an intensive survey of the habitat of the Myrtle's silverspot butterfly and research on the current abundance and distribution of the larval host plant and adult nectar sources.

The PRNS coastal dune system and coastal prairie provide critical habitat for the federally endangered Myrtle's silverspot butterfly. Many different plants are used by the Myrtle's silverspot butterfly as nectar sources; native plants (*Grindelia rubicaulis, Abronia latifolia, Monardella undulata, Erigeron glaucus,* and *Wyethia sp*.), as well as non-native bull thistle (*Cirsium vulgare*) and Italian thistle (*Carduus pycnocephalu*s). The only known larval host plant is the western dog violet (*Viola adunca*).

Axis and fallow deer frequent coastal prairie habitat. To date, it is not known whether they browse on the preferred nectar or larval host plants of the Myrtle's silverspot butterfly. Research in which deer-proof exclosures were monitored in the New Forest in England showed that fallow deer preferentially consumed a *Viola* species in a 1969 but not in a repeat survey in 1978 (Putman 1986). In Hawaii, the introduction of axis deer and mouflon sheep to Lana`i have likely played a major role in the disappearance of *Viola lanaiensis* (USFWS 1995a). Another Hawaiian species, *Viola kauaensis* var. *wahiawahensis,* is also listed as endangered by USFWS because of perceived threats of habitat degradation by feral animals and axis deer (USFWS 1995b). It therefore seems likely that non-native deer, given the opportunity, would graze on the Myrtle's silverspot butterfly's larval host plant.

Intensive grazing would further threaten the availability of these plants for the butterfly. If the fallow and axis deer populations continue to increase, the impact to the vegetation used by this butterfly would likely increase. Overall, the adverse impacts of Alternative A to Myrtle's silverspot butterfly in the Seashore and in Marin County would be moderate to major and long-term.

Bird Species of Concern

The Seashore has collaborated with the Point Reyes Bird Observatory over the past two decades to protect and restore habitat of nesting land birds within the boundaries of the Seashore. Many species of land birds are species of concern both under the California Bird Species of Special Concern (CDFG) and the Birds of Conservation Concern (USFWS). Examples of species include common yellowthroat *(Geothlypis trichas sinuosa*), California Swainson's thrush *(Catharus ustulatus oedicus),* and tricolored blackbird *(Agelaius tricolor).*

Numerous restoration projects and fire management actions have strived to improve nesting success in land birds, particularly in riparian areas. In addition, the park is an active member of the Partner-in-Flight program, collaborating with other agencies and organizations to protect and restore populations of neotropical migratory songbirds. The Point Reyes Bird Observatory has monitored the reproductive success and species composition of birds for more than 30 years. Monitoring has taken place in areas of the park (Palomarin) where fallow deer occur only rarely.

In areas where fallow deer are abundant, there often is a well-defined browse line on trees and shrubs between 1.5 and 2 meters above the ground. Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests have suggested that some bird species, namely understory nesters, declined with high deer grazing pressure (Fuller 2001). Similarly, ground or low nesting (approximately 0.0–3 meters) bird species found in the Seashore are vulnerable to heavy grazing by non-native deer. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). There may be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. The potential impacts on reproductive success and survival are unknown. Overall, the adverse impacts of Alternative A to understory nesting songbirds of concern in the Seashore and in Marin County would be moderate to major and long-term.

Plant Species of Special Concern

This category includes federal, state, and California Native Plant Society listed plant species identified below. Grazing by wild ungulates plays a role in the life history of many special-status plant species by removing understory and maintaining open habitat, encouraging reproduction in some species, and affecting competing species. Grazing can be detrimental to native plant species, especially when timing, frequency, and intensity are outside of the natural cycle to which the species is adapted (Archer and Smeins 1991). Grazing in California grasslands has been found to differentially affect various native life-history guilds such as annual or perennial forbs and grasses (Hayes and Holl 2003).

Although no research at PRNS has been conducted to document the extent to which non-native deer affect plant species of special concern, anecdotal and historical evidence and expert opinion can provide insight and guidance. Rare plants have been inventoried at Point Reyes National Seashore over the past twenty years. The preponderance of this information is presence/absence data for species of concern, with some additional data describing distribution of select species. Given the substantial amount of plant distribution data, it is important to note that this information only describes known rare plant occurrences. Obviously there are many acres within the Seashore that have not yet been surveyed for rare plants. Impacts related to rare plants, therefore, can only be estimated in terms of limited best available information.

Rare plants known to occur within current axis deer range include:

- *Arabis blepharophylla*, coast rock cress
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Cordylanthus maritimus ssp. palustris*, Point Reyes bird's beak *
- *Fritillaria liliaceae*, fragrant fritillary**
- *Grindelia hirsutula* var. *maritima* San Francisco Bay gumplant
- *Limnanthes douglasii* var. *sulphurea*, Point Reyes meadow foam*
- *Linanthus grandiflorus*, large-flowered linanthus
- *Triphysaria floribundus,* San Francisco owl's clover

Rare plants known to occur within current fallow deer range include:

- *Abronia umbellata ssp. breviflora*, pink sand-verbena
- *Agrostis blasdalei*, Blasdale's bent grass
- *Arabis blepharophylla*, coast rock cress
- *Arctostaphylos virgata*, Marin manzanita
- *Astragalus pycnostachyus var. pycnostachyus*, coastal marsh milk-vetch*
- *Calystegia purpurata* ssp. *saxicola*, coastal bluff morning-glory
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus var. gloriosus*, Point Reyes ceanothus
- *Ceanothus gloriosus var. porrectus*, Mt. Vision ceanothus
- *Chorizanthe cuspidata var. cuspidata,* San Francisco bay spineflower
- *Cordylanthus maritimus ssp. palustris,* Point Reyes bird's beak *
- *Elymus californicus,* California bottlebrush grass
- *Fritillaria affinis var. tristulis,* Marin checkerlily**
- *Fritillaria liliaceae*, fragrant fritillary
- *Gilia capitata ssp. chamissonis,* dune gilia
- *Grindelia hirsutula var. maritima* San Francisco Bay gumplant
- *Lilium maritimum,* coast lily**
- *Linanthus grandiflorus* large-flowered linanthus
- *Microseris paludosa,* marsh microseris*
- *Perideridia gairdneri ssp. gairdneri,* Gairdner's yampah
- *Polygonum marinense,* Marin knotweed
- *Ranunculus lobbii,* Lobb's aquatic buttercup*
- *Sidalcea calycosa ssp. rhizomata,* Point Reyes checkerbloom*
- *Triphysaria floribundus,* San Francisco owl's clover

* These species occur in wetlands or saltmarsh habitats. It is highly unlikely that these species are affected by non-native deer activities.
** Denotes bulb species.

Non-native deer can impact rare plant species directly by consuming and trampling them. PRNS staff observed fallow deer digging up and eating *Fritillaria sp.* bulbs within the burned area after the 1995 Vision Fire (Sarah Allen, NPS, personal communication). It should be noted that damage to *Fritillaria sp.* and other lily species has been observed outside exotic deer range, presumably caused by black-tailed deer or other herbivores (Michelle Coppoletta, NPS, personal communication). Based on analyses of deer diets conducted in Point Reyes, it can be inferred that after a major vegetation-changing event such as a

wildfire, both axis and fallow deer seek other food sources to supplement a depleted diet (Elliott 1983). This might include heavier foraging on bulb species.

Other species that may be impacted would be those occurring in areas of high-density herd congregations, where damage to plants through trampling would occur. Fallow deer herds have been observed often in grassland, evergreen scrub, and Douglas fir/redwood plant communities (NPS 2001b). These communities provide habitat for the plant species listed above. Adverse impacts to rare plants in the Seashore are currently considered to be minor and short-term. Alternative A would result in increased ranges and densities for both species and would likely lead to adverse impacts which were moderate and long-term.

There are no means of mitigating for impacts of non-native deer to the species of special concern of the Seashore.

Cumulative Impacts

Cumulative impacts are those effects that would result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As detailed above, the Alternative A could have direct and indirect short-term levels of adverse impact intensity that are considered minor; however, continued growth and expansion of the non-native deer population would result in a long term increase of impact intensity to major. An assessment of cumulative impacts on special status species considers the potential impacts that Alternative A may have in conjunction with the impacts on the same special status species resulting from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for special status species include:

- current and future livestock grazing and dairying
- the Giacomini wetlands restoration project
- Fire Management Plan implementation projects
- coastal watershed restoration (geomorphic sites) in Drakes Estero watershed
- coastal dune restoration
- Drakes Estero watershed restoration projects
- small restoration projects within the Seashore

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Special Status Species

Northern Spotted Owl. The threatened status listing is based on historic and projected trends in loss of habitat, large areas of low owl abundance, and declining trends in survival rates (USFWS 1990 and 1993). The Marin County spotted owl population is subject to threats present in the region including: (1) urban development along open space boundaries, (2) disturbance due to intense recreational pressures, (3) hazardous wildland fuel management practices, (4) potential for catastrophic wildfires along the urban/wildland interface, (5) possible genetic isolation, (6) continued range expansion of the Barred Owl, and (7) West Nile Virus.

Visitor use in the park is expected to increase along with the projected human population increase in the San Francisco Bay Area. With increased visitor use of the park, the potential for human disturbance of

owls along trails may increase. To reduce visitor impacts to owls, the park does not publish the location of owl activity centers and distributes a flyer on how to behave around owls.

Oaks in Marin and Sonoma counties have been dying suddenly over the past few years as a result of a fungus. The die-off, called sudden oak death, has spread throughout Marin County and occurs currently within owl habitat in the park. The death of the oaks results in local changes in percent cover and in food availability of the dusky footed woodrat, the primary prey of owls, at PRNS (Chow 1998). Widespread habitat conversion is not expected from SOD in the study area; however, park biologists are monitoring the distribution of the die-off.

An ongoing threat to spotted owls is development, which removes habitat and creates smaller blocks of forest, or forest that is discontinuous. Smaller isolated tracts of forest that would otherwise be suitable do not meet the needs of spotted owls, which require large contiguous blocks. Private land without conservation easements or other protection is most vulnerable to development. Several purchases of conservation easements, state parks and A-60 zoning (one house per 60 acres) has contributed positive cumulative impacts for owls.

The impact of a large wildfire on spotted owls would be habitat destruction. This species requires greater than 60% total canopy cover for nesting/roosting with large overstory trees, large amounts of down woody debris and the presence of trees with defects or signs of decadence in the stand. This old growth type forest in the park may have the high fuel loading and ladder fuels to feed a hot stand-replacing fire, which would eliminate the habitat for many years. In a large wildfire, such as the Vision Fire, the chances of directly destroying nests or habitat could be quite high. Suppression activities such as water and retardant drops would have an adverse effect on spotted owls if they occurred over nesting habitat and, especially, nests. Such events are less likely than direct destruction of nests or habitat to occur, and impacts would be mitigated if nest sites and probable nesting habitat could be avoided. Some impacts from fire management activities would be adverse and negligible to minor. Mitigations have been developed to avoid and eliminate any potential impacts.

Western Snowy Plover. Along the California coast, western snowy plovers have been extirpated from 33 of 53 nesting sites since 1970, and now number an estimated 1,387 plovers with 81 and 36 plovers recorded in Oregon and Washington, respectively (G.W. Page, personal communication) The 2002 estimate remains far below the populations size of 3,000 birds listed as the recovery objective. The USFWS Final Draft Pacific Coast Population of Western Snowy Plover Recovery Plan (2001) lists the main reasons for plover population decline as a combination of: human disturbance, urban development, introduced beachgrass (*Ammophila* spp.) and expanding predator populations.

Western Snowy Plovers have very specific feeding and nesting requirements associated with the rare coastal dune ecosystem. This limits their abundance and makes them vulnerable to continuing habitat loss. The association of snowy plovers to beach nesting areas has also made them susceptible to disturbance from recreational use and development. Increases in native and non-native terrestrial and avian predators associated with human development, such as Common Ravens (*Corvus corax*), raccoons (*Procyon lotor*), and Northern Harriers (*Circus cyaneus*) have also negatively impacted the plovers (USFWS 2001).

PRNS is 1 of only 20 remaining plover breeding areas in coastal California (USFWS 1993). The Point Reyes peninsula is one of the largest relatively undisturbed beach habitats on the California coast, providing a large area of potential snowy plover habitat free of threats that have degraded habitat elsewhere, such as development, off-road vehicle use, and heavy visitor use.

Fledging rates for snowy plovers before nest protection began were insufficient to maintain the species at PRNS, as indicated by declining numbers of nests and nesting adults in the period 1986-1995. Continuation of such low nest success rates could have resulted in loss of the PRNS breeding population of snowy plover. The current nest protection program has raised nest success rates to levels similar to those at other coastal California locations (USFWS 1999a), but would be costly to maintain indefinitely.

The Coastal Dune Restoration Project will increase breeding habitat for snowy plovers. This action and other Seashore's snowy plover management actions have benefited plover habitat and populations. Alternative A, with increased numbers and range of non-native deer, would reduce these beneficial impacts and result in adverse cumulative impacts.

California Red-legged Frog. As noted above, lands outside of PRNS and GGNRA offer substantial protection for wildlife through conservation easements, zoning, and low-impact land use practices. Extensive areas adjoining the study area preserve nearly 25,000 acres of public land, thousand of acres of conservation land privately held by non-profit groups, and over 30,000 acres of private land with conservation easements preventing development. In addition, much of western Marin is zoned at a very low density, particularly where it adjoins watersheds where red-legged frog habitat exists.

Additional impacts to frogs may come from restoration projects such as the Giacomini wetlands or fisheries in streams where frogs are known to occur. Impacts would be avoided, minimized, or mitigated however, and all project sites would be reviewed prior to implementation with the park GIS database. If there were potential for a take, the park would have staff specialists survey the site and provide recommendations for avoidance or mitigation. In the long-term, these fisheries restoration projects would benefit frogs by enhancing natural processes, including reduction of erosion and stream temperature and enhanced water quality.

Human activities may have had both direct and indirect effects on red-legged frogs. Development has removed habitat, and logging or other activities may have adversely affected geomorphological stability, erosion rates or river channels. For example, historic logging of parts of Inverness Ridge, channel alterations in the lower 2.8 km of Olema Creek, and the effects of highway culverting have removed suitable habitat along Olema Creek and its tributaries may have been. Areas of downcutting, bank cutting, and sedimentation are present along the mainstem and its tributaries, resulting in a probable reduction in numbers of backwaters and pools.

Ranching may also have adversely affected frog habitat, although since coming under NPS ownership and oversight, ranching practices on PRNS ranchland have been modified in ways that have likely benefited California red-legged frogs. Especially effective have been the reductions of cattle numbers on excessively grazed ranchlands and exclusion of cattle from a number of wetland sites. The species appears to be thriving under the current PRNS management of grazing lands, although cattle may be having adverse impacts in some locations. Fire can adversely affect frogs by removing riparian vegetation, and through the increase in sedimentation accompanying vegetation removal.

Coho Salmon, Steelhead Trout, and Chinook Salmon. Salmonid species on the west coast, including coho salmon, steelhead trout, and Chinook salmon have experienced dramatic declines in abundance during the past several decades as a result of human-induced and natural factors. There is no single factor solely responsible for this decline. Factors that threaten these species include water storage, withdrawal, conveyance, and diversions for various purposes. Direct and indirect effects of land use activities associated with human developments, agriculture, and recreation continue to alter fish habitat quantity and quality. As noted in other sections of this document, concentrated livestock agriculture in the form of dairy and beef operations persists inside Seashore boundaries. In areas that are managed for agriculture, tools to exclude livestock from sensitive areas, such as riparian zones and creeks, have been implemented

with great success. While it is acknowledged that cattle have major impacts to resources, there are tools for restricting their access to sensitive areas. Restricting access for non-native deer populations with fencing is impractical for anything other than small areas. Persistence of non-native deer would maintain concentration-associated adverse impacts to vegetation in areas no longer managed for agriculture.

The mouth of Lagunitas Creek and adjacent floodplain supports activities associated with the Waldo Giacomini dairy. This 550-acre property, once tidal wetlands, was diked and drained in the early 1940s to create pastures. For many years, a gravel dam was constructed annually just below the confluence of Lagunitas and Olema creeks for irrigation and stock watering. The dam created an abrupt transition from fresh to saline water for smolts and spawning adults, eliminating the transition zone found in an unimpaired estuarine system. The transition zone allows smolting fish time to adjust to saline conditions and provides productive feeding zones where both freshwater and saltwater invertebrates are available (SWRCB 1995).

The dam and the levees concentrated the area where spawning fish could hold and smolts could feed, and increased the potential for predation. While the annual construction of the dam has been discontinued, the levees are still in place. The NPS acquired these lands in 2000 and has developed a restoration plan. Primary site restoration activities are anticipated to begin in 2007. Such restoration is expected to improve estuarine smolt and adult emigration habitat for coho, steelhead and Chinook salmon.

The two projects Coastal Watershed Restoration (Geomorphic Sites) in Drakes Estero Watershed and the Coastal Watershed Restoration – Drakes Estero Road Crossing Improvement Sites together propose for nine sites within the Drakes Estero Watershed to be restored in 2007. The activities proposed through this project would remove or replace facilities such as road culverts and impoundments that impede natural freshwater and estuarine process.

Small creek restoration protection projects in watersheds supporting salmonids (e.g. Olema Valley) for coho salmon and steelhead trout have been completed or are underway These projects include removal of fish passage impediments, bank stabilization, and installation of fencing to protect riparian areas on Bear Valley Creek, Pine Gulch and Olema Creek and their tributaries. These projects have a minor, beneficial, long-term effect on coho salmon and steelhead trout, two listed speciesThe effects would be perceptible, but localized.
Overall these projects are will have a cumulative moderate beneficial effect on the federally listed coho salmon and steelhead trout.

California Freshwater Shrimp. Threats to existing populations of freshwater shrimp include deterioration and loss of habitat resulting from water diversion, impoundments, livestock and dairy activities, agricultural activities and developments, flood control activities, migration barriers, and water pollution (USFWS 1998). All of these threats occur along Lagunitas and Olema Creeks due to continued agricultural activities and human development around these waterways. As noted in other sections of this document, concentrated livestock agriculture continues in the form of dairy and beef operations persists inside Seashore boundaries. In areas that are managed for agriculture, tools to exclude livestock from sensitive areas, such as riparian zones and creeks, have been implemented with great success. While it is acknowledged that cattle have major impacts to resources, there are tools for restricting their access to sensitive areas. Restricting access for non-native deer populations with fencing is impractical for anything other than small areas. Persistence of non-native deer would maintain concentration-associated adverse impacts to vegetation in areas no longer managed for agriculture.

None of the projects in Appendix F have any anticipated impacts on freshwater shrimp.

Myrtle's Silverspot Butterfly. The U.S. Fish and Wildlife Service listed the subspecies as endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992). Habitat loss has occurred within the historic range of the butterfly, which extended approximately from Jenner Beach in southern Sonoma County, California to Point Ano Nuevo in San Mateo County, California (USFWS 1998). Urban development, conversion of native coastal prairie to cattle grazing, and invasion of non-native species have constrained the range of the Myrtle's silverspot butterfly. Currently, two populations of Myrtle's silverspot butterfly occur within the Seashore, another small population exists in southern Sonoma County and a larger population in an area of northern Marin County between Dillon Beach and Estero de San Antonio (Launer et al. 1992). Habitat conversion by invasive, non-native plants such as European beach grass (*Ammophila arenaria*) and iceplant (*Carpobrotus edulis*) are a serious threat to the remaining Myrtle's silverspot butterfly coastal habitats.

The largest numbers of Myrtle's silverspot butterflies documented in the early 1990s occurred on private land in the vicinity of Estero de San Antonio in Marin County northeast of PRNS. A golf course development proposed at that time was withdrawn, and the area is currently ranchland grazed by cattle and sheep. It is given a measure of protection from development by Marin County's agricultural zoning and policies to maintain the integrity of ranchlands in the western half of the county. Several of the ranches in the habitat area have sold development rights to the MALT, an organization seeking to preserve agricultural land in western Marin County. Any proposed development would have to comply with requirements of the Endangered Species Act to protect the Myrtle's silverspot.

While it is difficult to determine the status of Myrtle's silverspot population at PRNS given current information, the species does not appear to be at risk of extinction in the near future. Cattle grazing has been identified as only one of a number of possible reasons for the species decline, but is also considered valuable in maintaining Myrtle's silverspot habitat. While several areas have been identified where grazing may be adversely affecting the species' habitat at PRNS, overall grazing management has helped maintain a variety of plant cover conditions in Myrtle's silverspot habitats. The Coastal Dune Restoration Project will have a minor beneficial effect on silverspot populations.

Unlisted Species of Concern

NPS has developed a Fire Management Plan to outline future management of the fire program at PRNS and the North District of Golden Gate National Recreation Area. This plan includes a number of action alternatives that call for increased use of prescribed fire as a management tool to enhance natural resources and guard against catastrophic fire. Up to 3,500 acres annually of additional park natural and wilderness areas could be burned or mechanically treated over the next decade as a result of the Fire Management Plan. In light of observed consumption by non-native deer of rare bulb species after the 1995 Mount Vision fire, grazing pressure on *Fritillaria sp.* and other rare species in burned areas would likely increase after prescribed burns.

Overall, Alternative A, combined with the above projects and issues described, will have a long-term moderate to major cumulative adverse impact on special status species. The effects of increasing deer populations and range would not be significantly offset by the beneficial impacts of the above projects.

Conclusion

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests) exists in close proximity to PRNS, GGNRA and throughout Marin and Sonoma

Counties. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, impacts from deer to the species described above could become substantial, highly noticeable, or with the potential for landscape-scale effects. Because these species are already listed as threatened, endangered or of concern, the combined adverse effects of past and present activities have had an ongoing cumulative major impact. The spread of non-native deer outside the park with Alternative A would add to this adverse impact.

Based on current and past data on fallow and axis deer, the populations would continue to increase, resulting in expanded range and higher animal concentrations within the Seashore and Marin County. Ongoing impacts to species of special concern range from minor to major. Beneficial impacts to riparian species through habitat conservation and restoration activities are ongoing. The activities, pressures and trends which threaten the above species are ongoing cumulative adverse impacts. No impairment to special status species would occur from implementing Alternative A. All of the impacts associated with the presence and/or expansion of non-native deer populations are characterized as adverse. While short-term levels of adverse impact intensity are considered minor, continued growth and expansion of the population would result in an increase of impact intensity to major.

Type of Impact:	Adverse
Duration of Impact:	Mixed—both short-term and long-term
Intensity of Impact:	Minor in the short term, moderate in the long-term
Cumulative Impact:	Long-term moderate to major cumulative adverse impact on special status species.

Impacts on Human Health and Safety

Analysis

One of the actions common to all alternatives includes monitoring non-native deer numbers through ground or aerial surveys. Use of aircraft to monitor deer numbers or range expansion may result in minor, short-term adverse safety impacts to staff and visitors because of the risk of aircraft accidents. This risk is mitigated by strict adherence to Office of Aircraft Safety and Federal Aviation Administration regulations and policies for all NPS aerial operations (Director's Order 60).

In Alternative A, the numbers and range of both species of non-native deer are expected to increase, likely spreading beyond Seashore boundaries on to private and other public lands. A concomitant increase in deer-vehicle collisions over current levels, and throughout Marin County, is expected as a result. Such potential collisions constitute a minor, long-term adverse impact to human safety, both inside and outside Seashore boundaries.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As noted above, the Alternative A could have minor adverse effects on public health and safety. An assessment of cumulative impacts on public health and safety considers the potential impacts that Alternative A may have on public health in conjunction with the impacts on this same set of public health and safety activities from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for public health and safety include:

- Fire Management Plan implementation projects
- current dairy and beef ranching
- Cultural Resource restoration projects
- historic Point Reyes lighthouse rehabilitation
- Point Reyes Hostel improvements
- sewage system improvements

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Tule Elk Management Plan. The plan's action would have a short-term adverse effect by the limited use of motorized equipment in wilderness under the minimum tool concept. The localized use of helicopters or motor vehicles for short duration may increase safety risks to staff and visitors.

Dairy and Beef Ranching. Based upon monitoring results, the Seashore considers conditions at nine sites (8 subwatersheds) as degraded. Data from water quality monitoring has provided impetus to conduct field reconnaissance and additional sampling aimed at determining direct sources of pathogenic bacteria (e.g., livestock with direct access to streams). Trouble-shooting, problem solving, and best management practices implementation plans are underway for septic systems and dairies. For example, fencing has been installed or repaired at locations throughout the park. Focused monitoring of Kehoe Creek and Abbotts Creek has been initiated in order to differentiate sources (NPS 2004b). In addition, the two OLM stations identified below, are part of the Grazing BO monitoring project. Discussions to improve conditions within these watersheds are ongoing. Additional monitoring sites have shown exceedence of fecal coliform standards. In most cases, these sites are downstream of the degraded sites, and the higher readings are a result pollutant persistence in the water column.

While the Seashore has not designated water bodies specifically for recreational use, sampling for fecal and total coliform was performed at three of the most heavily used sites during summers1999 and 2000 (Hagmaier Pond, Vision Pond, and Bass Lake). Results indicate that water bodies not influenced by cattle grazing, remained far below any level of concern for contact recreation (Vision Pond and Bass Lake). Monitoring at Hagmaier Pond, a cattle stock pond, indicated short-term spikes of fecal coliform associated with the presence of cattle. Of 29 samples collected over two summers at Hagmaier Pond, 14% (4 samples) exceeded contact recreational standards (400 MPN/100ml). The duration of these fecal coliform spikes was typically less than one week. In response the Seashore posted warning signs at the pond, and access points, indicating the use of the pond by livestock, and associated risks (Ketcham 2001). These actions may mitigate some of the safety risks, and adverse impacts, of higher coliform counts in Seashore waters used by recreationists.

Point Reyes Hostel and Historic Lighthouse Improvements. The action will bring the facility into compliance with state, federal and Marin County health and safety regulations. Because of utility, housing and septic improvements, there are beneficial long-term direct impacts to public health and safety.

Cultural Resource Projects. The projects have moderate beneficial impacts to public health and safety by the upgrade of the buildings to code and upgrades to septic and water system.

Fire Management Plan. The actions in the FMP will have direct adverse, short-term and minor impacts to the health and safety of both the public and firefighters, except during large, high severity fire events, when the proximity of people to smoke and flame would result in major, short-term, and unavoidable adverse impacts.

Sewage Systems Improvements. Sewage systems upgrades have been conducted at Tomales Bay Marine Station at Sacramento Landing, within Olema Valley, and along Lagunitas Creek. The NPS headquarters buildings at Bear Valley also have received a new sewage system. New, major septic systems are planned at the Home Ranch and Point Reyes Lighthouse, and upgrades are planned for the Drakes Beach system. The Home Ranch sewage leach system for three houses will be moved to a location away from the Home Ranch creek area to address a water quality issue. The new leach field is directly north of the main Home Ranch complex. These projects will have minor beneficial long-term effects on public health and safety by removing localized potential pollutions sources.

The above projects and issues described will have a long-term beneficial and adverse major cumulative impact on public health and safety. This effect of Alternative A is negligible when viewed incrementally with the effects detailed above and does not change the overall cumulative effect.

Conclusion

Because of increased risk of deer-vehicle collisions, the No Action alternative would result in minor adverse impacts to human safety for staff, Seashore visitors and Marin County inhabitants. Because such impacts can be expected to recur indefinitely, they are characterized as long-term. When compared to all other alternatives, the No Action alternative would result in the greatest level of risk to human safety in this regard, although the use of firearms and possibly of aircraft to manage deer in each action alternative (B, C, D, and E) would present a higher safety risk overall. Based on the cumulative analysis, the long-term cumulative impact is both beneficial and adaverse, with minor to moderate intensity.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term beneficial and adverse minor to moderate

Impacts on Visitor Experience

Analysis

As a result of Alternative A, fallow and axis deer would increase in number in areas throughout the Seashore and opportunities for viewing non-native deer would increase slightly, a negligible to minor, long-term benefit to the visitor experience for the park visitors who hold aesthetic views as described in Affected Environment. Conversely, for those visitors seeking to view native black-tailed deer or who have more ecologistic views, a minor, long-term adverse impact is expected. Native deer viewing opportunities would be fewer and might require more time and effort on the part of the visitor because of adverse effects of non-native deer on native ungulates (see above Impacts on Wildlife – Alternative A). Under all action alternatives, the opportunities to view native deer species would improve as a result of the reduction of non-native deer numbers.

Increased numbers and density of non-native deer grazing in pastoral, wooded and riparian areas could change scenic viewsheds by suppressing undergrowth vegetation, shrubs and brush. The areas where such changes are most likely to be apparent to visitors are in Olema Valley (from fallow deer) and in the western pastoral areas of the Seashore (from axis deer). In these areas, agricultural grazing is the primary determinant of scenic viewsheds. The contribution which non-native deer would make to altering viewsheds is likely to increase over time with increasing deer densities, a negligible to minor adverse, long-term impact to the visitor experience related to viewshed enjoyment.

Monitoring of non-native deer occurs via helicopter counts, which may take place annually. The noise associated with these overflights would have a negligible long-term impact to visitors under this alternative.

Wilderness Character

NPS policies define wilderness character and values as including the primeval untrammeled character and influence of the wilderness; the preservation of natural conditions (including the lack of man-made noise); and assurances that there would be outstanding opportunities for solitude and the public would be provided with a primitive and unconfined type of recreational experience.

Like most wilderness areas in the National Wilderness Preservation System, the Point Reyes National Seashore Wilderness was not pristine when it was designated due to the history of Euro-American land use practices described in the Chapter 3, Affected Environment, including agricultural practices, introduction of non-native ungulates and fire suppression over the past century. As a result, "unnatural" conditions, with adverse ecosystem impacts, exist today. These impacts include the competition for forage between native and non-native ungulates, potential for disease transmission to native wildlife and destruction of woodland and riparian habitats. Scientific evidence indicates these conditions would continue to reduce the park's biological productivity without human intervention. Continuing current management (e.g., the No Action alternative) would result in continued impacts to wilderness natural resources further imprinting the effects of human uses. "Untrammeled" is a key word for wilderness management specialists and recreationists, and is most often defined both as showing no signs of external human influence and as offering an unconfined or unrestrained experience. If no changes to current management are made, ecological conditions in woodland and riparian habitats of the Seashore wilderness would worsen, and this portion of the wilderness would continue to show clear evidence of having been altered by external human influence, e.g. it would appear "trammeled." Minor adverse impacts to both these elements of wilderness character would occur.

However, visitors to the backcountry at the monument are able to find a solitary and quiet experience that may feel "primitive" and "unconfined." Because fewer people visit the backcountry, the chances of encountering other hikers is relatively low. The backcountry is quiet, with few sources of loud noise except commercial aircraft occasionally flying overhead. Unless these visitors are or have been made aware of the unnatural state of the Seashore's wilderness, they may believe that the area has been "affected primarily by the forces of nature."

Wilderness Values

Similar to the discussion of wilderness character, the values ascribed to wilderness are sometimes grouped in biocentric and anthropocentric categories. Those with biocentric values may most appreciate the natural or ecological conditions at PRNS, including protecting natural ecological processes, wildlife habitat, habitat for rare and endangered or unique plants and animals, protecting watersheds and water quality, etc. Anthropocentric values include experiential benefits from recreating in wilderness, educational values, generating tourism revenue for adjacent or nearby gateway communities, aesthetic and spiritual values, the knowledge that wilderness areas exist and would exist in the future, and intrinsic or symbolic values. Generally, the impact of continuing current management would have minor adverse impacts to those with biocentric values and impacts ranging from minor and adverse to minor and beneficial to those with anthropocentric values.

No impairment to this park resource would result from the No Action alternative.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As noted above, the Alternative A could have minor adverse and beneficial effects on visitor experience. An assessment of cumulative impacts on visitor experience considers the potential impacts that Alternative A may have on visitor experience in conjunction with the impacts on this same set of public health and safety activities from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for visitor experience include:

- Tule Elk Management Plan
- Fire Management Plan implementation projects
- Cultural Resource restoration projects
- current dairy and beef ranching
- historic Point Reyes lighthouse rehabilitation
- Point Reyes Hostel improvements
- Red Barn classroom
- historic Lifeboat Station marine railway rehabilitation

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Tule Elk Management Plan. The proposed action would have a short-term adverse effect by the limited use of motorized equipment in wilderness under the minimum tool concept. The localized use of helicopters or motor vehicles for short duration may have effects on wilderness users. Such transitory effects are deemed negligible and are clearly outweighed by the long term enhancement of this key attribute of the Seashore's wilderness.

Fire Management Plan. Prescribed burning would have minor beneficial effects by opening and restoring scenic vistas, but also short-term adverse effects on some visitor activities from blackening of vegetation with prescribed fires. The impact would be adverse and moderate and may extend to up to 50 days out of the year. Mechanical treatment may adversely affect park visitors through noise and closures. Impacts would be short-term and moderate.

Cultural Resource Restoration Projects, Dairy and Beef Ranching, Pacific Coast Learning Center, Tomales Bay Marine Station, North District Operations Centers, Historic Lighthouse Rehabilitation Project, Point Reyes Lifeboat Station Rehabilitation, Cultural Resource Projects, Point Reyes Hostel Improvements, and Red Barn Classroom. These projects overall have a cumulative beneficial major effect of visitor experience by providing scenic and historic features to be viewed by park visitors. The affected number of visitors is large (over 2.0 million visitors annually) and the overall cumulative effect could increase visitation.

The above projects and issues described will have a long-term and beneficial major cumulative impact on visitor experience. The effect of Alternative A is negligible when viewed incrementally with the effects detailed above and does not change the overall cumulative effect.

Conclusion

Based on data on current and past population growth of fallow and axis deer at PRNS, this alternative would result in an increase in fallow and axis deer numbers within the Seashore and throughout Marin

County. When compared to action alternatives, the opportunities to view native deer would be notably decreased under alternative A, while the likelihood of viewing non-native deer increases. Impacts to both wilderness character and wilderness experience would also occur. Impacts would be mixed depending on the social value of the visitor, and would be negligible or minor in either case. In addition, implementation of alternative A would likely increase adverse impacts to viewshed enjoyment over time as vegetation is removed.

The above projects and issues described will have a long-term and beneficial major cumulative impacts on visitor experience. The effect of Alternative A is negligible when viewed incrementally with the effects detailed above and does not change the overall cumulative effect.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Negligible to minor
Cumulative Impact:	Long-term beneficial major cumulative impact on visitor experience

Impacts on Park Operations

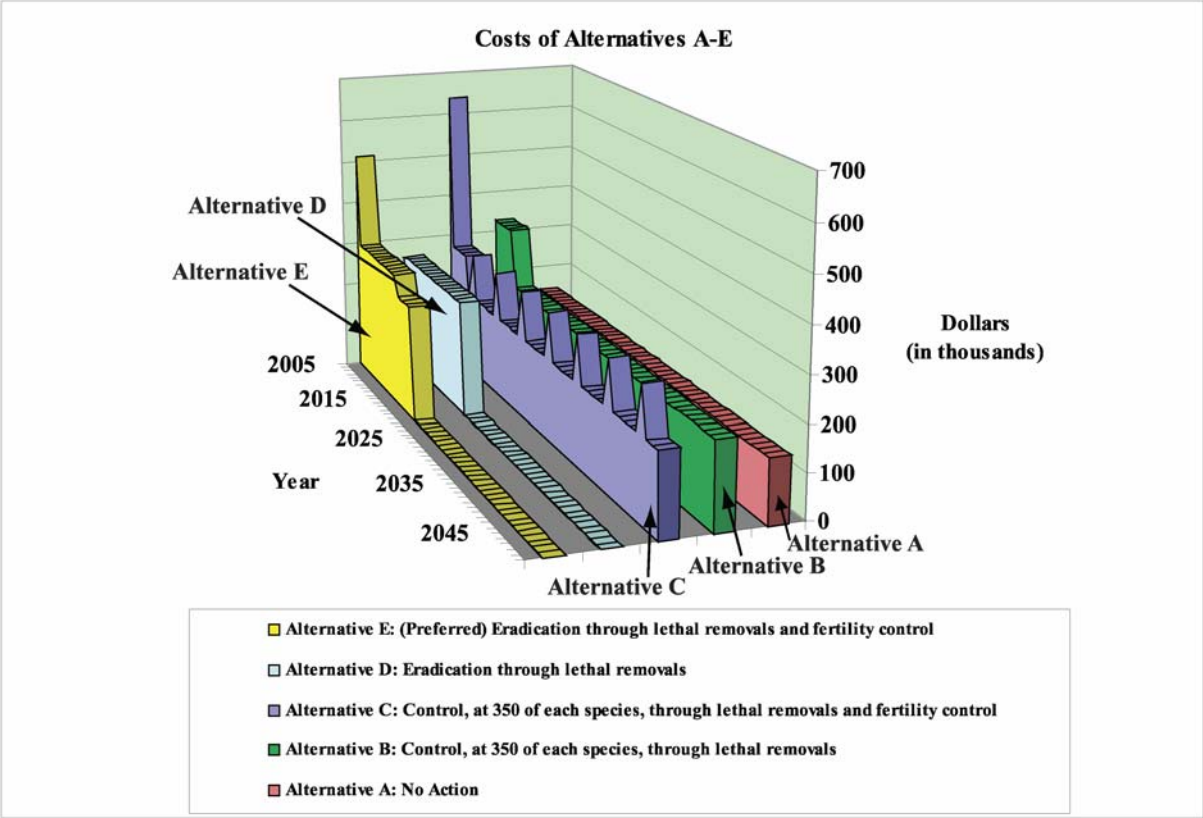
Under alternative A, potential effects associated with a growing population of non-native deer would result in increased allocation of funds and staffing to monitor and mitigate impacts to a broad spectrum of environmental, health and safety, and economic consequences analyzed elsewhere in this document. Operational costs and commitments would be expected to increase from both internal considerations and from increased coordination and cooperation outside the park. In addition, because this alternative results in presence of non-native deer in the Seashore in perpetuity, the costs would be incurred indefinitely.

Analysis

A growing population of non-native deer would result in increased allocation of funds and staffing to deal with and mitigate impacts to a broad spectrum of environmental, health and safety, and economic consequences analyzed elsewhere in this document. All impacts to park operations associated with continued monitoring of non-native deer and alleviation of impacts to natural resources and agriculture would be adverse.

Costs related to monitoring of large populations of non-native deer in the park are associated with impacts to natural and cultural resources. In FY 2003, personnel costs for 1.5 FTE (full time equivalents) and the costs of equipment, vehicles, supplies and staff for non-native deer monitoring (including one census yearly) totaled $126,000. Administrative and interpretive costs, excluding the costs of completing this document, comprised another $28,000. These costs, currently 2.9 % of the total PRNS annual budget, can be expected to double in the future with increasing non-native deer numbers and range. See Figure 17 for a comparison of the costs of the alternatives considered.

FIGURE 17: COMPARISON OF COSTS, ALTERNATIVES A-E, (BASED ON PRNS NON-NATIVE DEER COLLECTION DATA, 1984-1994 AND PRNS BUDGET DATABASES)



Note: Totals illustrated above, for comparison purposes, are minimum estimates of projected dollars spent by PRNS on monitoring or control programs. Costs of mitigating impacts to natural resources (as described in Chapter 4) could not be estimated and were not included.

Continuing costs to the park of mitigating impacts of non-native deer are unknown but would increase as their numbers increase under the No Action alternative. Such continuing adverse impacts include:

- Costs of disease monitoring and testing in areas of high deer density and where non-native deer are in close contact with livestock. Increased deer ranges and expansion into other areas in Marin County would require coordination and cooperation with state and federal regulatory agencies.
- Costs of erecting exclosures or deer-proof fencing in areas where high deer densities are adversely impacting sensitive resources, i.e., riparian areas or populations of rare plants.
- Costs of monitoring native species, such as native cervids, songbirds and special status species, adversely impacted by growing non-native deer numbers and range.

With increased densities and expansion of non-native deer beyond NPS boundaries likely under this alternative, the risk of costly litigation against the Seashore increases. Adverse impacts to agricultural lands outside the Seashore could engender suits against NPS from Marin County property owners. Increased numbers of deer-vehicle collisions, costly both in terms of human safety and material damages, as well as perceived risks to human health of aggressive non-native bucks during reproductive season, could engender suits against NPS from visitors and local inhabitants. All such litigation would result in substantial costs to the Seashore, in personnel time and potential monetary awards. Litigation costs are estimated at approximately $50,000.

Estimates for minimum cost for the implementation of the No Action alternative total approximately $2.1 million dollars by the year 2021. Thereafter, minimum annual costs could vary between $140,000 and $280,000 in perpetuity. The cost of implementing alternative A, a 5-15% increase in the total PRNS annual budget, can be expected to continue indefinitely.

Under the No Action alternative, non-native deer monitoring, mitigation of damage to natural resources associated with non-native deer, and potential litigation expenses could result in moderate, long-term, adverse impacts to park operations a result of increased budgetary commitments.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As detailed above, Alternative A could have moderate adverse effects on the park operations. An assessment of cumulative impacts on park operations considers the potential impacts that Alternative A may have on park operations in conjunction with the impacts on this same set of park operational resources from past, present and reasonable foreseeable future actions. Actions listed in Appendix F that contribute to the cumulative impact scenario for park operations include:

- Tule Elk Management Plan
- the Giacomini wetlands restoration project
- coastal dunes restoration project
- dairy and beef cattle ranching
- Fire Management Plan implementation projects
- Tomales Bay marine station rehabilitation
- coastal watershed restoration (geomorphic sites) in Drakes Estero watershed
- Drakes Estero watershed restoration projects

(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

The projects listed above are those activities that will impact the park operating costs. Other projects listed in Appendix F are either funded by a private party (for example, Point Reyes Hostel) or from existing operation funds. Based on potential operating costs for the all projects considered, the staff of the Seashore estimated the cumulative cost of the projects, when viewed incrementally with Alternative A, would be less than $840,000 or 15% or the current operating budget of $5.6 million. Some future operating costs would be offset by fee increase, non-profit assistance, or special grants.

Increased energy, inflationary, and health care costs, cost-of-living increases, along with static Seashore base funding, all result in recent yearly budgets in which personnel costs take an increasing share. Consequently, base funding for resource management projects is expected to continue to shrink as a proportion of the Seashore's yearly budget. Competition for funds would intensify in coming years between resource priorities, ranging from endangered species protection and restoration of degraded natural areas, to non-native deer management. Along with intensified competition for natural resource funding, Alternative A would adversely impact other important resource management projects in the Seashore and would represent an adverse, cumulative impact to park operations.

Invasive non-native species are playing an ever-increasing role in threatening native biodiversity worldwide and in national parks. Species such as ice plant (*Carpobrotus edulis*), European beach grass

(*Ammophila arenaria*), the bullfrog (*Rana catesbeiana*), and the green crab (*Carcinus maenas)* all threaten rare native species in the Seashore and constitute a growing problem for resource managers charged with mitigating their impacts. Because the cost of mitigating impacts of increasing deer populations competes directly for funding and staff time with these projects, Alternative A would result in adverse, cumulative impacts to park operations related to the protection of sensitive natural resources.

Cumulative impacts of Alternative A with the above actions are characterized as adverse, long-term and moderate.

Conclusion

In addition to cumulative impacts, park operations would be affected under this alternative as a result of greater demand on park staff to deal with increasing monitoring, impacts/mitigation for natural resources, associated management costs and possible litigation costs. All of the impacts associated with the presence and/or expansion of non-native deer are characterized as adverse and long-term (in perpetuity). Because additions in cost and/or energy usage under the No Action alternative would constitute 5-15% of the total PRNS budget, the impacts are considered to be moderate. The No Action alternative, out of all the considered alternatives, represents the greatest level of potential adverse impacts to park operations as a result of the expected increase in financial commitments that would be required indefinitely. Cumulative impacts of Alternative A with other projects and activities are characterized as adverse, long-term and moderate.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate
Cumulative Impact:	Adverse, long-term and moderate

Impacts on the Regional Economy

The impacts of growing population size and range would constitute an aggravation and an increase in scope of current impacts to ranchers and other farmers, both within and outside of the Seashore. Because non-native deer could be expected to spread into other parts of Marin County for the foreseeable future under the No Action alternative, growing impacts to agriculture would be long-term.

Analysis

No Seashore ranchers have reported any beneficial economic impacts of non-native deer. Conversations and letters from permittees indicate that current impacts to those ranchers who see non-native deer year-round include (refer to Regional Economy in Chapter 3, for greater detail on existing conditions):

- Fence repair costs ($500-$1000/yr per ranch [4 reports])—damage by non-native deer.
- Costs of lost pasture forage (unknown costs [4 reports])—pasture forage consumption by non-native deer.
- Costs of lost supplemental feed (unknown costs [1 report])—supplemental food put out for livestock eaten by non-native deer.
- Costs of reseeding pastures ($9000/yr per ranch [1 report])—overgrazing of fallow fields by non-native deer.
- Veterinary costs ($1200 in 2001 [1 report])—leptospirosis possibly transmitted by non-native deer.

Several cattle ranchers operating outside the Seashore boundaries described similar types of impacts and related costs of $3500-$4000/yr. One organic farmer located outside the park has experienced noticeable depredation of planted vegetables during the fall from fallow deer migrating out of the Seashore. It should be noted that this depredation is described by the farmer as different and more severe than any depredation from native deer. Because the population of non-native deer would increase, and deer would very likely range to areas outside the park under the No Action alternative (no population management), long-term, moderate, adverse impacts to the regional economy are possible and could increasingly influence the economic viability of agricultural operations inside the park boundaries.

The No Action alternative could have a disproportionate socioeconomic effects on minority and low-income populations countywide if agricultural operations that hire low income farm workers were forced to downsize in the future because of losses due to expanding non-native deer populations. Such downsizing on low-income farm workers would have negligible to minor, long-term adverse effects on the regional economy.

Because the No Action alternative requires no park closures, there would be no anticipated effects to local tourist businesses.

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests, including pasturelands) exists in close proximity to PRNS, GGNRA and throughout Marin and Sonoma Counties. The successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, impacts to agricultural operations in Sonoma and Marin Counties are likely. Because the impact could be quite widespread, it would be moderate or major in intensity and would persist indefinitely.

Cumulative Impacts

Cumulative impacts are those effects that could result when the impacts of Alternative A to a specific resource are added to the impacts of past, present and reasonable foreseeable future activities. As detailed above, Alternative A could have moderate direct and indirect adverse effects on the regional economy. An assessment of cumulative impacts on the regional economy considers the potential impacts that Alternative A may have on the regional economy in conjunction with the impacts on the regional economy from past, present and reasonable foreseeable future actions.

Actions and projects listed in Appendix F have been determined to all contribute to impacting the regional economy by providing a service, visitor experience, or facilities for the visiting public.
(Further detail on these projects can be found in Appendix F, Projects Considered in Cumulative Impacts Analyses. Other wider-ranging issues that may contribute to the cumulative analysis are described below).

Point Reyes National Seashore received 2.3 million visitors in 2001. The average visitor party spent $95 per party per night in the local area. This spending from visitors from outside the local region generated $83.6 million in sales for local businesses, yielding $39.3 million in personal income and supporting 2,000 jobs (NPCA 2002). Each dollar of tourism spending yielded another $0.63 in sales through the circulation of spending within the local economy. Including these secondary effects, the total economic impact was $113 million in sales, $42 million in wages and salaries, and 1,800 jobs (Michigan State University 2001).

The 165,000 acres of Marin County farmland produced olives, hay and silage, wine grapes, and organic produce earning in excess of $4 million in 2001 (Marin Agricultural Land Trust data 2003). Dairy and beef cattle produced about $40 million. Twenty percent of the Bay Area's milk supply is produced in Marin dairy farms. Countywide, two hundred farms and ranches employ 1,400 people.

A Biological Assessment was prepared in 2002 to review the proposed renewal of livestock grazing permits for areas managed by the Seashore and to determine to what extent renewing the permits might affect any of the federally listed threatened or endangered species (NPS 2002c). As mitigation for impacts of ranching operations on special status species, the Seashore is requiring permitees to alter some ranching practices which could result in added costs to permitees. Examples of such changes include increasing setbacks for livestock from riparian areas, delaying silage mowing, and improving drainage of livestock waste. Along with new requirements for agricultural permittees, increased numbers of non-native deer over a larger area of the Seashore resulting from Alternative A could constitute additional minor, adverse, cumulative impacts to the regional economy.

In summary, based on the above economic statistics, the overall incremental benefits of the park to the regional economy are major and beneficial.

Conclusion

Alternative A would continue existing minor adverse impacts to the regional economy indefinitely as non-native deer interfere with park ranching and grazing operations. Impacts to agricultural concerns could increase over time to a moderate, adverse level as the density of deer and the damage they cause increases. The impacts are considered minor to moderate because of the potential to impact a large number of businesses. Negligible to minor, adverse socioeconomic impacts are also possible to low-income/minority farm workers should the viability of agricultural operations be threatened under this alternative. As the populations of non-native deer expands outside the park, impacts to agricultural operations would become more widespread and could become major in intensity. When compared to all other alternatives, the No Action alternative would likely result in the highest degree of adverse effects to the regional economy.

The long-term cumulative impact of Alternative A and the projects considered in the cumulative analysis on the regional economy is major and beneficial. Although Alternative A has an adverse minor to moderate impact with the potential to become major, the scale of this economic impact when compared to the overall regional economic benefit of the park (both in dollars and number of businesses) is small.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate inside the park; major outside the park
Cumulative Impact:	Major and beneficial

Environmental Consequences of Alternative B – Control of Non-Native Deer at Pre-Determined Levels by Agency Removal

This alternative would control levels of fallow and axis deer to below estimated carrying capacity, at numbers that would be both logistically sustainable with NPS staff and funding, would keep deer from leaving the park, and would not likely lead to extinction of either species. In the 1970s and 1980s park staff controlled deer to 350 of each species. For purposes of analyzing impacts of this action alternative, the same levels (700 total non-native deer) would be assumed. Total numbers of non-native deer would be slightly less than current estimated numbers (approximately 250 axis deer and 860 fallow deer estimated in 2003) but high densities of deer in certain areas would still be expected because of the tendencies of both species to congregate in large herds. Initially, only fallow deer numbers would be curtailed by yearly shooting. In the future, when axis deer numbers surpassed the pre-established limit (for purposes of this analysis, 350), this species would also be culled. The age, sex and numbers of deer culled would be determined by resource managers to ensure that populations were maintained at desired levels and to reduce risks of range expansion beyond Seashore boundaries. The impacts to natural resources would differ little between Alternatives B and C.

Impacts on Water Resources and Water Quality

Analysis

The types of impacts to water resources associated with the presence of non-native deer are described in Alternative A, and include:

- loss of riparian vegetation through trampling, girdling and consumption, with resulting increases in runoff and erosion;
- streambank destabilization and loss, which also adds to sedimentation in streams;
- changes in stream morphology including decreases in stream depth and increases in stream width; and
- increases in bacteria and nutrients associated with waste products.

Because fallow deer tend to congregate in large herds and remain in an area for a long period of time, these effects are likely to be noticeable over time.

In addition to these types of impacts, fallow deer rip and tear riparian vegetation, dig holes, and create wide straight trails during the rut when bucks aggressively rub and thrash their antlers (Fellers and Osbourn 2006). Impacts of fallow deer grazing and thrashing to riparian vegetation, hydrology and water quality are most acute within the pastoral zone in Olema Valley, where many riparian areas have been deliberately excluded (with fencing) from livestock grazing on order to restore canopy and natural hydrologic processes. In these areas, heavy grazing, trampling, girdling and antler rubbing by non-native deer have severely retarded revegetation efforts and natural regrowth (B. Ketcham, NPS, personal communication). Continual grazing of new shoots and seasonal thrashing by fallow deer prevents native riparian plants from growing beyond shrub height. As noted above, without vegetation, soils are much more likely to erode in streamside forests and shrublands and would degrade water quality.

Because it leads to decreased non-native deer numbers in the Seashore in the short-term, Alternative B would result in localized improvements to water resources and water quality compared to the No Action alternative. These improvements include increased streambank stabilization, regrowth of riparian vegetation and improved capacity for runoff absorption and sediments stabilization, lowered suspended solids and lowered sedimentation of streams as soils stabilize, and less likelihood that water would be contaminated with bacteria or nutrients associated with animal feces. However, although impacts to water

resources and water quality would be less than those in Alternative A, they would remain minor to moderate in intensity, depending on the area, as the remaining fallow and axis deer would continue to congregate in areas adjacent to streams and have continued impacts as described above.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil erosion and potential for increased sedimentation of waterways. Alternative B specifies that NPS staff would attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country use of vehicles would rarely be used, particularly in wilderness and sensitive areas, adverse impacts to water resources from sedimentation resulting from this alternative are considered insignificant (See Appendix A, minimum tool analysis).

Past practice indicates that maintaining population sizes to 350 of axis and fallow deer is likely to keep them inside the Seashore boundaries. This is a potential substantial benefit of this alternative, compared to Alternative A, to regional water quality and water resources, since the expansion of the herds has the potential to exert the same types of impacts as described above on a regional scale if the No Action Alternative is adopted.

Unlike with livestock impacts, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of non-native deer to water resources and water quality.

Cumulative Impacts

Cumulative impacts of this alternative would be similar to those in Alternative A; that is, agricultural operations, removal of vegetation, burning and past logging practices have adversely affected many of the watersheds that are partially or completely inside the park, with the result that all watersheds inside the park exceed the recommended Total Suspended Solids standard. Restoration efforts, both inside the park and in partnership with other agencies are beneficial impacts to park water quality.

Maintaining populations of non-native deer long term would perpetuate concentration-associated impacts to hydrologic process in the lands no longer managed for agriculture. This alternative may also reduce the success and effectiveness of riparian restoration projects due to grazing, trampling and thrashing pressure by non-native deer on recovering native riparian vegetation. None of the projects described in the cumulative assessment of impacts to water quality would impede the continued impacts of non-native deer in the park. Though the cumulative impact scenario describes several restoration, rehabilitation and facility improvement projects that incrementally represent a substantial improvement to park and vicinity water resources, only the marsh restoration project would provide some treatment of water quality degraded by concentrations of non-native deer in Olema Valley. Non-native deer would continue to pass through the fences protecting sensitive resources from cattle. Cumulative impacts of Alternative B, when viewed incrementally with the above projects, would result in adverse long-term, moderate to major impacts to water resources inside and outside of the park.

Conclusion

Based on current and past data on fallow and axis deer, healthy non-native deer populations would remain, albeit at lower numbers, within the Seashore. No impairment to water resources would occur from implementing Alternative B. While benefits from slight population reductions would occur, continued presence of the two deer species would result in minor to moderate adverse impacts to hydrologic processes, aquatic habitat and water quality. Substantial benefits to water resources in the region relative to Alternative A are possible from reducing the risk of the expansion of non-native deer

outside the Seashore. Overall, cumulative impacts of Alternative B are adverse and moderate to major in intensity.

Type of Impact:	Beneficial and adverse
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor to moderate residual impacts
Cumulative Impact:	Adverse, long-term moderate to major

Impacts on Soils

Analysis

Alternative B would result in decreases in the number of fallow deer, and an increase to no more than 350 axis deer. Currently, fallow deer congregating in large herds and lekking fallow bucks are responsible for at least 120 acres of impacts to soils, and a reduction from nearly 900 animals to 350 would reduce impacts from current levels.

The types of impacts non-native deer have on soils in the Seashore are described in the impacts of Alternative A. These include the compaction and disturbance of soils, particularly in moist, riparian bottomlands of the Seashore, which leads to increased runoff and erosion. Axis and fallow deer also use riparian areas for feeding and shelter, and can consume large quantities of vegetation, or damage and destroy vegetation by girdling, trampling or breaking trails. Fallow deer trails are wider than native deer trails, cross streams and can erode substantially in the rainy season. Fallow bucks also destroy vegetation through behaviors during the rut, including polishing their antlers and scraping and pawing the ground. These areas of affected shrubland or forest can be quite obvious in the Seashore, (totaling 4 acres in the Bear Valley area alone) and the bared ground becomes erodable during the fall and winter. Each of these areas, where loss of vegetation and root destabilization has occurred, are subject to erosion and soil loss. If the impact is severe, it can be perpetuated indefinitely since vegetation does not grow back as readily where soils are compacted or where top layers are lost.

Unlike with livestock, where fencing and grazing limits are effective, there are no means of mitigating for impacts of non-native deer to soil resources. However, the reduction in the number of animals in the park could mean at least some of these areas where deer congregate would not be occupied, or would be occupied with fewer deer. It is possible that a negligible or minor improvement in soils in known fallow deer habitat would occur, although historic data suggest the difference would not be highly noticeable. During the first few years, before axis herds increase and as fallow herds are thinned, a minor short-term benefit may occur.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil compaction. Alternative B specifies that NPS staff would attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country use of vehicles would rarely be used, particularly in wilderness and sensitive areas, adverse impacts to soils from compaction resulting from this alternative are considered negligible or minor.

The greatest benefit of implementing this alternative to soils may be the much reduced risk of non-native deer expanding beyond park boundaries. If Alternative A were implemented, damage to soils could become regional in nature and major in its intensity. Relative to that alternative, maintaining the herds at 350 each could have substantial benefits to landowners outside the park.

Cumulative Impacts

Cumulative impacts to soils within the Seashore would be similar to those described for Alternative A. These include compaction, changed nutrient levels and denudation associated with livestock operations inside the park.

Soil compaction from cattle at the Seashore is restricted to the pastoral zone and by fencing. Non-native deer may feed in that zone as well, and compaction by deer would add to the impacts caused by cattle. Outside of the pastoral zone, non-native deer are adding to compaction in riparian areas and areas outside the pastoral zone.

Alternative B will add to impacts of erosion from past practices like logging, and from the Vision Fire and development.

Although adverse cumulative impacts would be less relative to No Action, there would remain cumulative adverse effects on soils. Based on the number of acres with soil impacts in Alternative B, the adverse impacts on soil resources would not be significantly offset by the beneficial impacts of some of the projects reviewed in the cumulative analysis and, along with continued cattle ranching, would continue to present a long-term, adverse major impact on the soil resources within the park. The total cumulative number of acres with adverse soil impacts would exceed 500 acres, characterizing the total impact as major.

Conclusion

Based on current and past data on fallow and axis deer, congregating non-native deer would continue to adversely affect soils through trampling, compaction and denuding sites even at the lower population sizes that would exist if Alternative B were selected. No impairment to soils would occur from implementing Alternative B. A negligible to minor short-term improvement to soils in some localized areas currently used by non-native deer could occur in the first few years, although the continued presence of large herds of axis and fallow deer would result in long-term minor to moderate, adverse impacts. Substantial benefits relative to Alternative A, from lower risk of non-native deer expanding outside the park and affecting soils regionally, are likely.

Based on the number of acres with soil impacts in Alternative B, the adverse impacts on soil resources would not be significantly offset by the beneficial impacts of the projects described in the cumulative analysis and, along with continued cattle ranching, would continue to present a long-term, adverse major impact on the soil resources within the park.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor to moderate
Cumulative Impact:	Adverse, long-term major

Impacts on Vegetation

Analysis

The types of impacts non-native deer can have on vegetation are described above under the Impacts of Alternative A. To summarize, they include consumption, girdling, trampling and loss from behaviors such as creating trails and antler thrashing during the rut. These, in turn, have indirect effects on vegetation,

through increased compaction and erosion of soils, which make revegetation difficult; and through changes in nutrients and responses by plants to grazing. Deer also have impacts on the physical structure of vegetation, species richness and species composition across landscapes, as well as distribution of seeds and nutrients.

Heavy browsing by deer can remove the middle and lower levels of vegetation, and create a browse line that reaches from the ground to as high as the deer can reach. It can also keep trees and shrubs from reaching their full height, and can eliminate palatable species entirely from an area. In some cases, theses species are rare or protected, or the vegetative community affected by deer grazing is unique. In the extreme, ungulate grazing can change woodlands into grasslands, can prevent succession from open grasslands to shrublands or forests and can create vegetative communities composed of only a few species. In the park, one unique community that is heavily affected by fallow deer is riparian. Fallow deer congregate in streamside shrublands and forests, particularly during the rut, and may remain there for long periods of time. In addition to removing vegetation by grazing, deer trampling and compaction of soil, rutting behaviors and trail breaks can result in severe loss of riparian vegetation locally. In some cases, the park has deliberately attempted to restore riparian areas by fencing out cattle, only to have the fences breached by fallow deer and the riparian areas degraded. Densities of fallow deer can reach 80 per square kilometer, several times higher than that of white-tailed deer in areas of Pennsylvania where major changes in species richness and vegetative cover were noted (NPS 2002a; deCalesta 1997).

Because it would quickly reduce total numbers of fallow deer in the Seashore, Alternative B would result in some short-term reduction of current moderate to major impacts to vegetative processes (associated with plant establishment and regrowth), habitat (associated soil erosion and plant growth rates), and plant diversity (associated with preferential grazing and browsing). However, as axis deer populations grow and the total number remains at 700, the difference in impacts to vegetation over the long term between this alternative and Alternative A are more likely to decrease, and adverse moderate impacts would persist indefinitely.

The major benefit of implementing this alternative to vegetation may be the reduced risk of non-native deer expanding beyond park boundaries. If Alternative A were implemented, damage to vegetation could become regional in nature and therefore, by the definitions described in Chapter 4, Methodology, would become major in intensity. Relative to that alternative, maintaining the herds at 350 each could have substantial benefits to landowners outside the park.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor direct destruction of vegetation. Alternative B specifies that NPS staff would attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Indirect impacts from capture or culling operations would also include increased potential for the dispersal of non-native plant seed and vegetative propagules. In addition, operation of vehicles could compact soils and trample vegetation, making regrowth more difficult. Because cross-country use of vehicles would rarely be used, particularly in wilderness and sensitive areas, adverse impacts to vegetation from destruction resulting from this alternative are considered negligible or minor.

Cumulative Impacts

Cumulative impacts would be similar to those identified for Alternative A. These include ranching operations, as well as restoration operations conducted by the park. These restoration efforts include working with the agricultural community to modify operations within the lease areas to reduce adverse impacts associated with livestock concentration. Ranching operations have been reduced from their historic extent (on the entire Point Reyes Peninsula) to only 25% of the overall land area. Nearly all of the remaining 75% of Seashore lands is managed as natural or wilderness areas. Some of these areas are

returning to shrub and forest communities without the "clearing" effects of livestock grazing. In areas that are managed for agriculture, tools have been implemented to exclude livestock from sensitive areas, such as riparian zones and creeks.

Based the effects in Alternative B on vegetation and the adverse cumulative effects of the projects in the cumulative analysis, the adverse impacts on vegetation resources would be moderate to major. Cumulative impacts from ranching activities could be irreversible and substantial. Beneficial impacts of some of the above projects would not significantly offset the adverse impacts of ranching and non-native deer.

Conclusion

This alternative would maintain non-native deer at slightly reduced numbers within the Seashore and throughout Marin County. No impairment to vegetation would occur from implementing Alternative B. Based on current reports of damage to riparian and understory vegetation within the Seashore, the magnitude of current impacts to vegetation within NPS boundaries are currently considered moderate to major in intensity, depending on the area. Under this alternative, the impact intensity is expected to decrease slightly initially, but remain moderate because of localized high deer densities and geographic scope over the long term. Substantial benefits are likely relative to Alternative A from lowering the risk of non-native deer expansion outside the park and reducing impacts to vegetation regionally.

Based the effects in Alternative B on vegetation and the adverse cumulative effects of the projects in the cumulative analysis, the adverse impacts on vegetation resources would be moderate to major. Cumulative impacts from ranching activities could be irreversible and substantial. Beneficial impacts of some of the above projects would not significantly offset the adverse impacts of ranching and non-native deer.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed—both short-term and long-term
Intensity of Impact:	Moderate
Cumulative Impact:	Adverse, long-term moderate to major

Impacts on Wildlife

Analysis

In the following analysis, the best professional judgment of wildlife biologists, as well as research completed at the Seashore and elsewhere, have been used to provide guidance for evaluating impacts of increasing fallow and axis deer populations and range on other wildlife species.

Non-native Cervids

The increased population size for axis deer, which would result from this alternative, would clearly benefit that species. Range would likely increase within the Seashore.

Because fallow deer populations would initially be reduced to 350, this alternative has adverse impacts for fallow deer in PRNS. Current fallow deer range maps suggest that fallow deer have spread recently towards the south and eastward borders of the Seashore. Any deer control program involving lethal removal of animals with firearms has the potential to scatter deer herds and push deer out of the Seashore

into adjacent lands. Provisions in Alternative B that specify removing animals from the edges of the Seashore before culling animals deeper within the park would mitigate such scattering. However, large numbers of fallow deer on the Vedanta Society property would remain outside NPS management authority.

Impacts to non-native deer from Alternative B would be beneficial to axis deer and adverse to fallow deer. Because change in total deer numbers and range are expected to be small and Alternative B calls for maintenance of non-native deer in PRNS indefinitely, impact intensity is considered minor and long-term.

Alternative B, because it results in shooting of non-native deer, would cause a measure of pain and suffering to culled animals. The degree of pain and suffering would be mitigated by use of trained agency sharpshooters for all control operations. Culling would be conducted by NPS staff or contractors specifically trained in wildlife sharpshooting. (In addition to other federal contracting requirements, for the purposes of this plan, a contractor is a fully insured business entity; non-profit group or government agency engaged in wildlife management activities that include trapping, immobilization and the lethal removal through sharpshooting and chemical euthanasia. The contractor must possess all necessary permits and be able to pass any needed security clearances.) Efforts would be made to deliver immediately lethal shots to target animals and sharpshooters would be required to complete NPS range qualifications specifically designed for ensuring humane and effective wildlife removal.

Native Cervids

In their study of axis and fallow deer introductions nationwide, Feldhammer et al. (1993) stated:

> "We may expect competition between exotic and native artiodactyls both intuitively, and on the basis of previous field experiments with a variety of animal groups from various trophic levels and habitats…"

Native black-tailed deer are primarily browsers while both axis and fallow deer have been shown to be grazers. However, studies at PRNS have demonstrated that, during times of low forage availability, non-native deer adapt their feeding habits and consume larger amounts of forbs and browse (Elliott 1983; Elliott and Barrett 1985; Fallon-McKnight 2006). Elliott could not detect statistically substantial effects of non-native deer on black-tailed deer fawn production or survival. He suggested that densities of exotic deer present in 1973 ($\leq$ 17 deer / sq. km. or 350 of each species) would not negatively affect the density of black-tailed deer. A review of Elliott's 1982 dietary overlap study by Gary Fellers, a U.S. Geological Survey scientist, suggested that exotic deer at levels of 350 for each species could reduce the native black-tailed deer population size by up to 30%. If black-tailed deer numbers are strongly influenced by the energy content of their diet, the reduction in their population, when fallow deer number 350, could be as much as 40% below carrying capacity (Fellers 1983 and 2006).

700 non-native deer would result in competition with native black-tailed deer for forbs and browse during droughts, at the end of summer, and year-round on poor quality ranges (Connolly 1981; Elliott 1983; Fellers 1983). Competition for limited forage would result in decreased condition in black-tailed deer (Brunetti 1976; Fellers 1983). It has been repeatedly shown in the scientific literature that poor condition in adult female cervids results in decreased reproductive capacity (Verme 1962, 1967; Thorne et al. 1976; Keech et al. 2000). Competition for forage would likely result in reduced black-tailed doe fertility, decreased long-term fawn production and lower fawn survival, although, in the short-term, all these parameters would be improved over current levels. The magnitude of the impacts to black-tailed deer populations would depend on range conditions, precipitation patterns and non-native deer numbers but would likely range from minor to moderate and could be expected to last longer than two breeding cycles. It is important to note that adverse impacts to black-tailed deer from increased competition would occur

throughout larger portions of the Seashore's pastoral zone and some natural areas if axis deer range expands in the future as a result of this alternative.

Continued presence of non-native deer in areas of the Seashore where free-ranging tule elk inhabit would likely inhibit expansion of the elk herd and may suppress elk numbers where the new free-ranging subpopulations are not well established. These areas include the southwestern wilderness areas of the park south of Drake's Estero and west of Inverness ridge.

Tule elk, like fallow and axis deer, are primarily grazers. Grasses constitute a large proportion of the diets of all three species year-round (Elliott and Barrett 1985; Gogan and Barrett 1985; Fallon-McKnight 2006). Fallow deer, present at Limantour but not Tomales Point (the two locations of tule elk populations in the Seashore), may impact sympatric elk in the Limantour area in their foraging for forbs, grasses and especially, *Plantago* spp. (a high energy and high protein forage). (Fallon-McKnight 2006). Competition between elk and fallow deer for forbs likely continues throughout spring and summer, which is a time that both species are nursing young. Increased grazing pressure on this and other important forage items by fallow deer could potentially deprive Limantour elk of the nutritional benefits of these food resources at a critical time (Fallon-McKnight 2006). In addition to inhibiting further expansion of tule elk herds, 700 non-native deer in the Seashore would likely continue to adversely impact current elk populations in the Seashore through competition for forage (Brunetti 1976). Such impacts would be reflected in lower elk calving rates, delayed onset of reproduction in tule elk cows and reduced elk calf survival.

Direct behavioral competition between fallow deer and tule elk currently exists at PRNS and would likely continue, albeit at lower levels, with Alternative B. Researchers in the Zehusice Deer Park in the Czech Republic have documented behavioral exclusion of red deer (a subspecies of elk similar in size to tule elk) by fallow deer at high-density feeding sites (Bartos et al. 1996). Fallow deer at Zehusice were observed to: (1) be consistently more aggressive than red deer, (2) preferentially seek out feeding sites where red deer congregated, and (3) attack red deer from the rear as a strategy to overcome their larger opponents (Bartos 1996). In the Tomales Point Elk Reserve at PRNS, fallow bucks have been observed sparring with tule elk bulls (PRNS unpublished data (m)). In all observed instances, fallow bucks were successful in chasing away elk bulls in spite of a major size disadvantage. The consequences of a decrease in behavioral competition are difficult to predict with certainty but could include decreased exclusion of elk from higher quality forage or habitat, improved condition of reproducing adults and ultimately, increased population growth.

Paratuberculosis, or Johne's disease, is an infectious and incurable diarrheal wasting disease of wild and domestic ungulates. In a study conducted at PRNS in 1979, paratuberculosis was documented in 9.6% and 8.1% of axis and fallow deer, respectively (Riemann et al. 1979b) and reconfirmed in axis deer in 2000 (NPS unpublished data (g)). The disease has been documented in tule elk at Tomales Point Elk Reserve since 1980 (Jessup et al. 1981). In spite of their known susceptibility to the disease, black-tailed deer have not been documented to carry paratuberculosis in PRNS (Williams et al. 1983; Sansome 1999 unpublished report). Few black-tailed deer at PRNS have been tested for Johne's disease and it is possible that the disease causes rapid death in this species (E. Manning, Johne's Testing Center, personal communication). In 1998-1999, relocation of 45 adult tule elk from Tomales Point to the Limantour wilderness area included a 6-month quarantine and extensive testing for Johne's disease (Manning et al. manuscript in press). Only those animals that consistently tested negative on all blood tests and fecal cultures were released in July 1999 to form a new free-ranging herd. This elk herd is currently made up of 45 animals. The goal of the relocation was to restore the dominant native herbivore to the Seashore's wilderness ecosystems.

Transmission of the organism that causes paratuberculosis (*Mycobacterium avium ss. paratuberculosis*) occurs primarily from infected adults to young animals. The period of greatest susceptibility for this

infection is the first 6 months of life. The organism is shed by infected animals into feces that may contaminate feed, water, and pastures. The prevalence of the infection and the incidence of clinical disease may climb when an affected population approaches carrying capacity. At these high densities, affected herds experience the stressors of reduced forage nutritional quality and reduced ability to fight disease. This immunosuppression can result in increased transmission of infection and progression to clinical illness as well as heavier parasite loads (Manning et al. 2003). Animals in the clinical phase of Johne's disease shed the organism more often and in greater numbers. Premise contamination with this hardy and long-lived organism may thus increase, a factor relevant to the health of numerous species. All cervids are believed to be susceptible to this infection (Manning and Collins 2001). In Alternative B, non-native deer populations would be controlled below carrying capacity. The potential for transmission to tule elk and black-tailed deer, which share their habitat, would be minor.

As noted in the analysis of Alternative A, ectoparasites on fallow and axis deer have been newly discovered. These three species of lice pose an unknown but potentially significant risk of disease to native black-tailed deer and tule elk. Pediculosis, resulting from the inter-species transfer of both chewing and sucking lice to cervids has been well documented in the literature (Brunetti et al. 1971; Foreyt et al. 1986; Westrom 1976; Bildfell et al. 2004). USDA researchers and NPS managers are concerned that clinical disease resulting from transfer of any non-native lice to native deer could cause increased morbidity, mortality and reduced recruitment of young. Alternative B would result in lower densities of fallow deer and higher densities of axis deer in PRNS and outside of NPS boundaries. The potential for transmission to the tule elk and black-tailed deer that share their habitat is unknown but is considered minor to moderate.

Genetic variability assists populations in adapting to environmental changes and reduces vulnerability to catastrophic events such as disease, abnormal weather cycles, pollution etc. Fewer than 4,000 of the 500,000 tule elk historically present in California, currently remain. Tule elk at PRNS have passed through four severe population reductions or "bottlenecks". With each bottleneck, the amount of genetic variability in the population has been reduced. It has been estimated that PRNS elk are among the most inbred in California, with a degree of relatedness equivalent to that resulting from three consecutive brother-sister matings (McCullough et al. 1996). Physical signs of inbreeding, such as cleft palate, have been observed in the Tomales Point herd (Gogan and Jessup 1985).

Management techniques to increase genetic diversity within and among wildlife populations include: (1) translocating animals between subpopulations, and (2) increasing the number of reproducing animals within each subpopulation (McCullough et al. 1996). For the past 5 years, NPS has cooperated with California Department of Fish and Game to transfer adult elk cows to Tomales Point, in order to increase genetic variability. One of the primary goals of the PRNS General Management Plan is to maintain viable populations of tule elk in the Seashore and to restore free-ranging elk to wilderness ecosystems. Alternative B would likely slow the growth of tule elk numbers required to increase genetic variability in the Limantour elk herd. Competition for resources with fallow deer and minor potential for transmission of paratuberculosis could adversely impact herd growth. Smaller numbers of breeding animals would result in lower genetic variability and increased risk of catastrophic population downswings.

Alternative B would result in:

- decreased tule elk and black-tailed deer food availability;
- slowed growth or reduction of tule elk and black-tailed deer numbers;
- decreased expansion of tule elk range; and
- reduced potential for increased genetic variability within a the PRNS tule elk population.

Depending on precipitation and range conditions, impacts to native cervids from Alternative B within and outside of NPS boundaries would be beneficial and moderate in the short-term. In the long-term, continued presence of non-native deer in the Seashore would constitute moderate adverse impacts.

Small Mammals

The impacts of 700 non-native deer on small mammals would occur in two ways: (1) by beneficial or adverse habitat alteration, influencing food supply and cover, and (2) by direct, adverse competition for resources, mainly, food (Flowerdew and Ellwood 2001). In order to definitively demonstrate impacts of deer populations on small mammals at PRNS, large-scale deer exclosure experiments would have to be used to investigate responses at varied deer densities. Such experiments have not been carried out at PRNS. Evaluation of impacts to small mammals is guided by research completed in the U.S. and in the U.K. on fallow deer and white-tailed deer in lowland woodlands (Putman 1986; McShea 2000; Flowerdew and Ellwood 2001; Fuller 2001). Inventories of small terrestrial vertebrates, conducted at PRNS from 1998-2001 in the agricultural and ungrazed areas of the Seashore, were also considered in this analysis (Fellers and Pratt 2001).

In the Britain, heavy grazing pressure (100 deer/ sq. km. by fallow deer in lowland forests caused reductions and even local extirpations of wood mice, bank voles and common shrews (Putman et al. 1989). The loss of palatable ground-level vegetation removes food sources for small herbivores and at the same time, changes microclimates and reduces protection from predators (Flowerdew and Ellwood 2001). Increased browsing of shrubs in forested habitat or on forest-grassland interfaces, as has been demonstrated in both axis and fallow deer at the end of summer and during droughts (Elliott 1982), could alter suitability of those areas for some species. High densities of fallow deer year-round as well as fallow bucks during the breeding season have been observed to alter woodland and riparian cover and vegetation at PRNS through browsing and antler thrashing (Fellers and Osbourn 2006; B. Ketcham, NPS, personal communication). Such high-density impacts could decrease cover and habitat for the dusky-footed woodrat (*Neotoma fuscipes*).

Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). Densities of fallow deer in the Olema Valley areas of PRNS currently approach 80 deer/ sq. km. (NPS 2002a) and could be expected to decrease in some of these areas with Alternative B. However, the Vedanta Society property, which supports the highest densities of fallow deer, is outside NPS management authority and no deer would be removed there. It is likely that deer densities would remain unchanged or might increase with Alternative B if deer from neighboring NPS lands are pushed on to Vedanta lands with park removal operations. Grazing pressure from non-native deer in many Olema Valley sites is currently considered heavy. Should this grazing pressure continue or increase with Alternative B, species that could be adversely affected are the: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*). High, localized non-native deer densities resulting from Alternative B would likely reduce habitat for these species in limited areas of the Seashore. Higher axis deer densities resulting from Alternative B could impact small mammal habitat in other areas of the Seashore if axis deer range increases. The adverse impacts are considered minor and long-term.

Not all species decline with increasing deer grazing pressure. Grazing at intermediate and low deer densities has been shown to increase or have no effect on some plant and animal species in Britain (Fuller and Gill 2001). At PRNS, deer mice (*Peromyscus maniculatus*) were found more often in pastures grazed by cattle than in pastures where cattle were excluded (Fellers and Pratt 2002). It is possible that with the

continued localized grazing pressure resulting from Alternative B, deer mouse abundance would increase in PRNS and countywide. The Valley pocket gopher (*Thomomys bottae*), another small mammal species that thrives in open grassland environments, could also remain unaffected or increase.

Direct competition for food between non-native deer and small mammals is a potentially adverse impact resulting from Alternative B. As stated before, definitive documentation of competition would require exclosure experiments. In the absence of such experimentation, evidence of dietary overlap between species has been evaluated. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996; Jurek 1977). In addition, analyses of fallow and axis rumen and fecal samples have shown heavy use of many of the same species used by small mammals (Elliott 1982; Fallon-McKnight 2006). Small mammals likely to be adversely affected by increasing competition for food are the: Pacific jumping mouse (*Zapus trinotatus*), California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus)*, western harvest mouse (*Reithrodontomys megalotis*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*).

Depending on local deer densities, weather patterns and the yearly mast crop, overall impacts to small mammals from Alternative B are considered to be adverse and range from minor to moderate in the Seashore. Because impacts would persist for longer than 2 breeding cycles, they are considered long-term.

Mammalian and Avian Predators

This category includes wildlife species, such as mountain lions (*Felis concolor*), coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), badgers (*Taxidea taxus*), weasels (*Mustela spp.*) and the raptors that prey on small mammals.

Although no research at PRNS has been conducted to document the extent to which non-native deer are preyed upon by carnivores, anecdotal and historical evidence suggest low-level predation, especially on fawns. Since their introduction in the 1940s, there has been a decrease in the proportion of observed white fallow deer, from 75% to 21%, suggesting that white individuals may be preferentially selected by predators (Wehausen 1973; NPS 2002a). An anecdotal report exists of an axis doe defending her fawn from a bobcat (NPS unpublished data (n)). Ranchers have reported coyotes preying on axis fawns in the pastoral zone (N. Gates, NPS, personal communication). However, because non-native deer congregate in large groups and prefer open habitat, it is unlikely that they serve as a primary prey base for native mega- and meso-carnivores, which specialize on stalking black-tailed deer and small mammals. Alternative B would likely leave the prey base for mountain lions, coyotes and bobcats essentially unchanged over current conditions. The expected long-term decrease in both the black-tailed deer and small mammal prey base for these carnivores, foxes, weasels and badgers resulting from Alternative B would cause minor adverse impacts to these predators.

In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls (*Strix aluco*) and kestrels (*Falco tinnunculus*), especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely adverse long-term impact on their rodent prey base, especially in areas of high deer densities, Alternative B would have an adverse impact on birds of prey such as great-horned owls (*Bubo virginianus*), short-eared owls (*Asio otus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), red-shouldered hawks (*Buteo lineatus*), red-tailed hawks (*Buteo jamaicensis*), Northern harriers (*Circus cyaneus*), black-shouldered kites (*Elanus caeruleus*), sharp-shinned hawks (*Accipiter striatus*), and Cooper's hawks (*Accipiter cooperii*).

Overall, the adverse impacts of Alternative B to predators in the Seashore and in Marin County would be minor to moderate and long-term.

Other Birds

Little is known about the impacts of grazing wildlife on birds in the Seashore. In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle and in ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Only one species, the savannah sparrow (*Passerculus sandwichensis*), was found in higher numbers in grazed grasslands.

Deer exclosure studies in Pennsylvania hardwood forests indicate that high densities of white-tailed deer (*Odocoileus virginianus*) cause declines in intermediate canopy-nesting songbirds. This study showed complete absence of certain songbird species, including American robins (*Turdus migratorius*), at deer densities over 25 deer/ sq. km. (deCalesta 1994). These declines are thought to occur because high deer numbers alter the structure of woody and herbaceous vegetation 0.5 - 7.5 meters above the ground (deCalesta 1994). Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests suggested that some bird species, namely understory nesters, declined with high deer grazing pressure while other species, namely bark foragers, benefited from reductions in understory vegetation. Researchers in British lowland forests determined that "losers" substantially outnumbered "winners" and that breeding populations of migrant birds were especially vulnerable to adverse impacts from heavy deer grazing pressure (Fuller 2001).

Table 10 lists the ground or low nesting bird species (nesting at approximately 0.3–3 meters) found in the Seashore. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). Impacts to the species listed would likely occur in a manner similar to the Pennsylvania study (deCalesta 1994). That is, there would be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. Impacts on reproductive success and survival are unknown. It should be noted that Table 10 primarily contains species breeding at PRNS and GGNRA and is not exhaustive. Two species that would likely be impacted, the San Francisco common yellowthroat (*Geothlypis trichas sinuosa*), and the California Swainson's thrush (*Catharus ustulatus oedicus*) are not listed in this table because they are either California Bird Species of Special Concern (CDFG) or Birds of Conservation Concern (USFWS) and are discussed in the Impacts on Species and Habitats of Management Concern section.

TABLE 10: BIRD SPECIES LIKELY TO BE ADVERSELY IMPACTED BY ALTERNATIVE B. (T. GARDALI, POINT REYES BIRD OBSERVATORY, PERSONAL COMMUNICATION, SHUFORD AND GARDALI, IN REVIEW)

Common Name	**Scientific Name**
Allen's hummingbird	*Selasphorus sasin*
American goldfinch	*Carduelis tristis*
Bewick's wren	*Thryomanes bewickii*
Brewer's blackbird	*Euphagus cyanocephalus*
California towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*

Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Marsh wren	*Cistothorus palustris*
MacGillivray's warbler	*Oporornis tolmiei*
Orange-crowned warbler	*Vermivora celata*
Oregon junco	*Junco hyemalis thurberi*
Red-winged blackbird	*Agelaius phoeniceus*
Spotted towhee	*Pipilo maculatus*
Western meadowlark	*Sturnella neglecta*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*

In areas of PRNS and GGNRA, it is expected that overall avian species richness, abundance and diversity would decrease measurably in areas of continued heavy grazing pressure resulting from Alternative B. Beneficial impacts to a few grassland species would be offset by larger adverse impacts to relatively more species that depend on understory shrub layers for nesting, especially in impacted riparian and woody-grassland interfaces. The adverse impacts to various species would range from minor to moderate in intensity, depending on precipitation and range conditions, and would be long-term within NPS boundaries.

Reptiles and Amphibian

Some information is available on the impacts of large herds of grazing herbivores on reptiles and amphibians in the Seashore. During inventories of small vertebrates conducted at PRNS in 2001, northern alligator lizards (*Gerrhonotus coeruleus*) were not found in pastures grazed by cattle but were found in similar ungrazed sites (Fellers and Pratt 2002). Changes to woodland understory vegetation, especially in riparian areas, as has been documented with fallow deer at PRNS, would alter microclimates and habitats for frogs, lizards and salamanders. Adverse impacts could be expected for: alligator lizards, California slender salamanders (*Batrachoseps attenuatus*), rubber boas (*Charina bottae*), western skinks (*Eumeces skiltonianus*), racers (*Coluber constrictor*), garter snakes (*Thamnophis elegans)*, and Ensatina salamanders (*Ensatina eschscholtzii*).

Because of expected mild to moderate adverse impacts of Alternative B on small mammal abundance (see above), concomitant decreases can be expected in reptiles that prey on shrews and rodents. Species in this category are the: western terrestrial garter snake, rubber boa, and gopher snake (*Pituophis melanoleucus*).

Studies of British lowland forests heavily grazed by fallow deer have shown that as a result of decreasing rodent numbers, kestrels relied preyed more heavily on lizards (Putman 1986). Inside the Seashore, similar increases in predation by raptors and owls on lizards, frogs and snakes is likely to occur in areas of high non-native deer density.

Impacts to amphibians and reptiles in PRNS with Alternative B are expected to be adverse to a number of species. The impacts range from minor to moderate and are long-term.

Because Alternative B is likely to control the expansion of non-native deer outside Seashore boundaries, substantial benefits to wildlife resources affected by non-native deer are likely to occur relative to No Action.

Cumulative Impacts

Cumulative impacts to wildlife under this alternative would be similar to those described for Alternative A. These include adverse impacts to biodiversity of agricultural practices and statewide declines in the number of black-tailed deer related to losses and degradation of habitat. The actions that caused this decline include urbanization, fire suppression and changes in logging (CDFG 1998). As noted above, non-native deer compete with native black-tailed deer, and losses and degradation of native deer habitat in the region have additive adverse impacts on this species.

Losses of acorns as a source of food from sudden oak death, a fungal-type disease that kills tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and black oaks (*Quercus kelloggii*) are also aggravated by fallow deer, which feed on them. As noted in the description of cumulative impacts to wildlife for Alternative A, non-native wild turkeys also use acorns as a food source. Turkey numbers are also increasing across Marin County. Adverse cumulative impacts to many species of small mammals, for which acorns are an important food source, are likely under this alternative.

Overall, Alternative B, combined with the projects and issues described in the cumulative analysis (see Alternative A), will have a long-term moderate cumulative adverse impact on wildlife. The effects would not be significantly offset by the beneficial impacts of any of the projects described in the analysis.

Conclusion

Data on current and past population growth of axis deer at PRNS indicate that this alternative would result in a decrease in total non-native deer numbers over current levels (to 700) within the Seashore (beneficial impacts compared to the No Action alternative). Axis deer range is expected to increase in pastoral and natural areas of the Seashore. No impairment to native wildlife would occur from implementing Alternative B. Based on research on impacts of non-native deer to wildlife in other countries as well as known impacts of grazing by cattle and white-tailed deer in the U.S., the impacts of Alternative B are expected to be beneficial to a few native species and adverse to a larger number of native species. Pockets of extremely high non-native deer density, such as those currently seen in Olema Valley, are likely to be found in the Vedanta property and limited areas within the Seashore. Native species richness and diversity would likely decrease in those high-density areas. Overall, the magnitude of impacts to native wildlife within and outside of NPS boundaries are considered moderate in intensity, adverse and long-term.

Overall, Alternative B, combined with the projects and issues described in the cumulative analysis, will have a long-term moderate cumulative adverse impact on wildlife.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed—both short-term and long-term
Intensity of Impact:	Moderate
Cumulative Impact:	Long-term moderate adverse

Impacts on Species and Habitats of Management Concern

This category includes federally listed wildlife species, other species of concern recognized by the state of California, and bird and plant species of concern. Birds of Conservation Concern (USFWS) include several species of nesting land birds and raptors.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect listed species, anecdotal, historical evidence and expert opinion can provide insights and guidance. The federally listed species that are likely to be affected by non-native deer include northern spotted owls (*Strix occidentalis caurina*), western snowy plover (*Charadrius alexandrinus nivosus*), California red-legged frog (*Rana aurora draytonii*), Coho and Chinook salmon (*Oncorhynchus kisutch and Oncorhynchus tshawytscha*), steelhead trout (*Oncorynchus mykiss*), and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

Analysis

Special Status Species

Northern Spotted Owl

The northern spotted owl is a federally threatened species that reaches the southern limit of its range within GGNRA, PRNS and Muir Woods National Monument in Marin County, California. Data collected by the NPS indicates that these parks may support the highest density of spotted owls known. However, the population is geographically isolated and subject to unique threats including urban development, intense recreational pressure, habituation of owls to humans, potential for catastrophic wildfires, and changes in hazardous fuel management practices. Owls occur throughout the forested lands in the Seashore and the population is likely stable; however, owls have been monitored for only 7 years in the Seashore (NPS and Point Reyes Bird Observatory unpublished data). Owls prey almost exclusively on small mammals, particularly dusky-footed wood rats (*Neotoma fuscipes*) in the Seashore (Chow 1998). Woodrats, in turn, are dependent on roots, stems, leaves, seeds and mast (Linsdale and Tevis 1951; Willy 1992).

Fallow deer have been recorded in areas where spotted owls nest and roost. To date, no direct effects have been noted on the productivity or survival of owls. However, deer compete with the prey species of owls, and therefore, likely have an indirect negative impact on food resources. By biting off buds and flowers they reduce the amount of seed and fruit available in autumn and winter. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996; Jurek 1977). In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls and kestrels, especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely minor adverse impact on rodent prey base due to competition for forage, Alternative B would have an indirect adverse impact on northern spotted owls. Overall, the adverse impacts of Alternative B to owls in the Seashore and in Marin County would be minor and long-term.

Western Snowy Plover

Western snowy plovers, federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS), nest along the sandy beaches of the Seashore, primarily on Point Reyes Beach between North Beach and Kehoe Beach. Historically, plovers also nested at South Beach, Drakes Beach and Limantour. Plover nesting success has increased slightly over the past few years due to intensive management by the Seashore; however, the species is vulnerable to numerous activities in the park including predation by ravens and disturbance by recreationists. Fewer than 20 chicks fledged in 2002 (Peterlein 2002). Cattle roaming on the beaches in the past were a potential source for disturbance; however, the Seashore now intensively restricts cattle from beaches. A large herd of 60 axis deer has been seen on South Beach within the last five years, and where the herd occurred, the ground was heavily impacted (S. Allen, NPS

personal communication). The frequency of this activity by axis deer is unknown but likely does not occur with regularly. Because Alternative B results in higher populations of axis deer within the Seashore, such impacts may increase slightly in frequency. Consequently, the overall adverse impact of Alternative B to plovers in the Seashore is likely minor, depending upon whether plovers nest again at South Beach or whether axis deer expand onto the North Beach to Kehoe Beach area.

California Red-legged Frog

The California red-legged frog was federally listed as a Threatened species on June 24, 1996. Red-legged frogs breed in ponds or pools during the wet season (December through March), and use ponds and/or riparian habitats during the rest of the year. Fallow deer regularly frequent riparian areas and vigorously rub and thrash their antlers during the rut, resulting in maiming and destruction of riparian vegetation (Fellers and Osbourn 2006). While engaged in this activity, fallow deer cause extensive trailing and may trample frogs. Damage to the vegetation could lead to degradation of non-breeding habitat. Overall, the adverse impacts of Alternative B to frogs in the Seashore and in Marin County would be minor and long-term.

Coho Salmon, Steelhead Trout, and Chinook Salmon

Anadromous fish, listed as endangered or threatened by National Marine Fisheries Service (NOAA Fisheries), occur in many of the streams of the Seashore, particularly in Olema Creek and Lagunitas Creek. In 2004, the California Department of Fish and Game (CDFG) approved listing coho salmon in this Evolutionary Significant Unit as Endangered under the California Endangered Species Act. In their 2001 Status Review, NOAA-Fisheries acknowledged that within the evolutionary significant unit, the decision to list coho salmon as threatened may have been overly optimistic, concluding that the evolutionary significant unit population was presently endanger of extinction (NMFS 2001). As a result of these and further findings, NOAA-Fisheries completed a rulemaking process in June 28, 2005, which downgraded the coho status (upgraded listing protection) in the evolutionary significant unit to Endangered (Federal Register 2005a).

The Seashore contains 10% of the last remaining wild population of coho salmon within the Central California Coast Evolutionarily Significant Unit, and consequently, any loss of this population would have an impact on the evolutionary significant unit. The NPS, along with the NOAA Fisheries and the CDFG, have conducted intensive fish surveys and have funded and implemented numerous restoration projects along the streams that flow through the park and adjacent lands. Numerous culverts have been removed along with other blockages to fish passage. In addition, the agencies have installed fencing to restrict cattle from riparian areas. These fences, however, do not impede the movement of fallow deer.

Fallow deer regularly frequent riparian areas and damage the riparian vegetation, particularly during the rut when bucks thrash branches and leaves with their antlers and girdle small trees and saplings (Fellers and Osbourn 2006). While engaged in this activity, fallow deer indirectly affect the fish by damaging riparian plants, resulting in: increased erosion and sediment delivery to the stream, reduced cover, and potentially warmer water in streams due to exposure to sunlight. Persistence of fallow deer would prolong this impact to riparian vegetation. In addition, continued presence of non-native deer would reduce the success and effectiveness of riparian restoration projects for salmon due to grazing and thrashing pressure on recovering native riparian vegetation. In restoration areas, revegetation efforts and natural regrowth would be severely retarded due to heavy grazing and antler rubbing. Different from browsing where leaves are plucked from a stem, this constant grazing and thrashing prevents native riparian plants from growing beyond shrub height. In riparian areas where large numbers of fallow deer congregate or travel, fish redds can be trampled, adversely impacting reproduction in all 3 species. Overall, the adverse impacts of Alternative B to anadromous fish in the Seashore and in Marin County would be minor and long-term.

California Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is listed by the USFWS as Endangered. The shrimp inhabits lower Lagunitas Creek and lower Olema Creek, within the current fallow deer range at PRNS. Shrimp are highly dependent on overhanging riparian vegetation, under which they live year-round. Fallow deer have not been observed within known shrimp habitat. However, in other areas of both Lagunitas and Olema Creeks, high densities of fallow deer have been observed to browse and trample riparian vegetation (Fellers and Osbourn 2006). A decrease in fallow deer range resulting from Alternative B is likely to result in no detectable change, e.g. a negligible impact to this species.

Myrtle's Silverspot Butterfly

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) is one of three coastal subspecies of *S. zerene* in the Western United States. The USFWS listed the subspecies as endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992).

As of 1998, three populations are known to remain. The USFWS Myrtle's Silverspot Butterfly Recovery Plan (1998) estimated the three populations combined comprise 10,000 individuals. Two populations of Myrtle's silverspot butterfly occur within the Seashore and the third is on private land in northern Marin County. The Center for Conservation Biology at Stanford monitored distribution and abundance of the Myrtle's silverspot butterfly at Point Reyes National Seashore almost yearly from 1992 to 1998. The Stanford survey work shows a decline in Myrtle's silverspot butterfly population levels during the six-year period and the central population to be "barely existing" (Launer et al.1998). Grazing is believed to deplete the Myrtle's silverspot butterfly larval host plants. The Seashore is currently supporting an intensive survey of the habitat of the Myrtle's silverspot butterfly and research on the current abundance and distribution of the larval host plant and adult nectar sources.

The PRNS coastal dune system and coastal prairie provide critical habitat for the federally endangered Myrtle's silverspot butterfly. Many different plants are used by the Myrtle's silverspot butterfly's as nectar sources; native plants (*Grindelia rubicaulis, Abronia latifolia, Monardella undulata, Erigeron glaucus,* and *Wyethia sp*.) as well as non-native bull thistle (*Cirsium vulgare*) and Italian thistle (*Carduus pycnocephalu*s). The only known larval host plant is the western dog violet (*Viola adunca*).

Axis and fallow deer frequent coastal prairie habitat. To date, it is not known whether they browse on the preferred nectar or larval host plants of the Myrtle's silverspot butterfly. Research in which deer-proof exclosures were monitored in the New Forest in England showed that fallow deer preferentially consumed a *Viola* species in a 1969 but not in a repeat survey in 1978 (Putman 1986). In Hawaii, the introduction of axis deer and mouflon sheep to Lana`i have likely played a major role in the disappearance of *Viola lanaiensis* (USFWS 1995a). Another Hawaiian species, *Viola kauaensis* var. *wahiawahensis,* is also listed as endangered by USFWS because of perceived threats of habitat degradation by feral animals and axis deer (USFWS 1995b). It therefore seems likely that non-native deer, given the opportunity, would graze on the Myrtle's silverspot butterfly's larval host plant.

Intensive localized grazing would further threaten the availability of these plants for the butterfly. If fallow and axis deer populations persist in the Seashore and axis deer range increases, potential adverse impacts to larval host plants and nectar sources persist. Overall, the adverse impacts of Alternative B to Myrtle's silverspot butterfly in the Seashore and in Marin County are considered moderate and long-term.

Bird Species of Concern

The Seashore has collaborated with the Point Reyes Bird Observatory over the past two decades to protect and restore habitat of nesting land birds within the boundaries of the Seashore. Many species of land birds are species of concern both under the California Bird Species of Special Concern (CDFG) and the Birds of Conservation Concern (USFWS). Examples of species include common yellowthroat *(Geothlypis trichas sinuosa*), California Swainson's thrush *(Catharus ustulatus oedicus),* and tricolored blackbird *(Agelaius tricolor).*

Numerous restoration projects and fire management actions have strived to improve nesting success in land birds, particularly in riparian areas. In addition, the park is an active member of the Partner-in-Flight program, collaborating with other agencies and organizations to protect and restore populations of neotropical migratory songbirds. The Point Reyes Bird Observatory has monitored the reproductive success and species composition of birds for more than 30 years. Monitoring has taken place in areas of the park (Palo Marin) where fallow deer occur only rarely.

In areas where fallow deer are abundant, there often is a well-defined browse line on trees and shrubs between 1.5 and 2 meters above the ground. Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests have suggested that some bird species, namely understory nesters, declined with high deer grazing pressure (Fuller 2001). Similarly, ground or low nesting (approximately 0.0–3 meters) bird species found in the Seashore are vulnerable to heavy grazing by non-native deer. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). There may be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. The potential impacts on reproductive success and survival are unknown. Overall, the adverse impacts of Alternative B to understory nesting songbirds of concern in the Seashore and in Marin County would be minor to moderate and long-term.

Plant Species of Special Concern

This category includes federal, state, and California Native Plant Society listed plant species.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect plant species of special concern, anecdotal and historical evidence and expert opinion can provide insights and guidance. Rare plants have been inventoried at Point Reyes National Seashore over the past twenty years. The preponderance of this information is presence/absence data for species of concern, with some additional data describing distribution of select species. Given the substantial amount of plant distribution data, it is important to note that this information only describes known rare plant occurrences. Obviously there are many acres within the seashore that have not yet been surveyed for rare plants. Impacts related to rare plants, therefore, can only be estimated in terms of limited best available information.

Rare plants known to occur within current axis deer range include:

- *Arabis blepharophylla*, coast rock cress
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Cordylanthus maritimus ssp. palustris*, Point Reyes bird's beak *
- *Fritillaria liliaceae*, fragrant fritillary**
- *Grindelia hirsutula* var. *maritima* San Francisco Bay gumplant
- *Limnanthes douglasii* var. *sulphurea*, Point Reyes meadow foam*
- *Linanthus grandiflorus*, large-flowered linanthus
- *Triphysaria floribundus,* San Francisco owl's clover

Rare plants known to occur within current fallow deer range include:

- *Abronia umbellata ssp. breviflora*, pink sand-verbena
- *Agrostis blasdalei*, Blasdale's bent grass
- *Arabis blepharophylla*, coast rock cress
- *Arctostaphylos virgata*, Marin manzanita
- *Astragalus pycnostachyus var. pycnostachyus*, coastal marsh milk-vetch*
- *Calystegia purpurata* ssp. *saxicola*, coastal bluff morning-glory
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus var. gloriosus*, Point Reyes ceanothus
- *Ceanothus gloriosus var. porrectus*, Mt. Vision ceanothus
- *Chorizanthe cuspidata* var. *cuspidata*, San Francisco bay spineflower
- *Cordylanthus maritimus ssp. palustris*, Point Reyes bird's beak *
- *Elymus californicus*, California bottlebrush grass
- *Fritillaria affinis var. tristulis*, Marin checkerlily**
- *Fritillaria liliaceae*, fragrant fritillary
- *Gilia capitata ssp. chamissonis*, dune gilia
- *Grindelia hirsutula* var. *maritima* San Francisco Bay gumplant
- *Lilium maritimum*, coast lily**
- *Linanthus grandiflorus* large-flowered linanthus
- *Microseris paludosa*, marsh microseris*
- *Perideridia gairdneri ssp. gairdneri*, Gairdner's yampah
- *Polygonum marinense*, Marin knotweed
- *Ranunculus lobbii*, Lobb's aquatic buttercup*
- *Sidalcea calycosa ssp. rhizomata*, Point Reyes checkerbloom*
- *Triphysaria floribundus*, San Francisco owl's clover

* These species occur in wetlands or saltmarsh habitats. It is highly unlikely that these species are affected by non-native deer activities.

** Denotes bulb species.

Non-native deer can impact rare plant species directly by consuming and trampling them. PRNS staff observed fallow deer digging up and eating *Fritillaria* bulbs within the burned area after the 1995 Vision Fire (Sarah Allen, NPS, personal communication). It should be noted that damage to *Fritillaria sp.* and other lily species has been observed outside exotic deer range, presumably caused by black-tailed deer or other herbivores (Michelle Coppoletta, NPS, personal communication). Based on analyses of deer diets conducted in Point Reyes, it can be inferred that after a major vegetation-changing event such as a wildfire, both axis and fallow deer would seek other food sources to supplement a depleted diet (Elliott 1983). This might include heavier foraging on bulb species.

Other species that may be impacted would be those occurring in areas of high-density herd congregations, where damage to plants through trampling would occur. Fallow deer herds have been observed most often in grassland, evergreen scrub, and Douglas fir/redwood plant communities (NPS 2001b). These communities provide habitat for the plant species listed above. Adverse impacts to rare plants in the Seashore are currently considered to be moderate and short-term. Long-term, Alternative B would result in little overall change in densities for both species and would likely lead to adverse impacts which were minor and long-term.

There are no means of mitigating for impacts of non-native deer to the species of special concern of the Seashore.

Cumulative Impacts

Cumulative impacts would be the same as those described for Alternative A.

Depending on the species of concern, adverse, long-term cumulative impacts might range from moderate to major.

Conclusion

No impairment to special status species would occur from implementing Alternative B. All of the impacts on special status species, associated with the continued presence and/or expansion of non-native deer populations, are characterized as adverse. While short-term impacts of reduced fallow deer numbers may be beneficial to wildlife and plant species that currently suffer adverse impacts, long-term persistence of axis and fallow deer in the Seashore would result in adverse impacts of minor to moderate intensity.

Depending on the species of concern, adverse, long-term cumulative impacts might range from moderate to major.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed—both short-term and long-term
Intensity of Impact:	Minor to moderate
Cumulative Impact:	Adverse, long-term and moderate to major (depending on the species of concern)

Impacts on Human Health and Safety

Analysis

Under Alternative B, the use of firearms by NPS staff and contractors as the sole method of control and maintenance of non-native deer numbers may increase related risk of injuries to staff and visitors. As this activity would continue indefinitely under Alternative B, minor, short-term (transitory, individual culling efforts) to long-term (indefinite duration of activity), adverse impacts to staff and visitor safety resulting from risk of firearms injuries are expected.

Under Alternative B, the numbers and range of both species of non-native deer are expected to decrease through lethal removal to a number totaling 700. A concomitant decrease in deer-vehicle collisions over current levels is expected, a minor, long-term benefit to human safety similar to effects expected under Alternative C.

Cumulative Impacts

Cumulative impacts would be the same as those described for Alternative A.

The projects and issues described in the cumulative analysis will have a long-term beneficial and adverse major cumulative impact on public health and safety. This effect of Alternative B is negligible when

viewed incrementally with the effects detailed in the cumulative analysis and does not change the overall cumulative effect.

Conclusion

Alternative B would result in minor adverse impacts to human health and safety for Seashore visitors and staff over an indefinite period of time due to risk of firearms-related accidents. In addition, minor benefits to public safety can be expected through the likely reduction in deer-vehicle collisions under Alternative B. When compared to the No Action alternative, the use of firearms under this alternative would result in increased risks to human health and safety of indefinite duration. Conversely, decreasing numbers of non-native deer numbers under Alternative B would result in a slight reduction of human safety risks compared to Alternative A.

The projects and issues described in the cumulative analysis will have a long-term beneficial and adverse major cumulative impact on public health and safety.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term adverse and beneficial, minor to moderate

Impacts on Visitor Experience

Analysis

This alternative would eventual result in the reduction of non-native deer to fewer than are in the Seashore today. As a result, it is possible that those visitors with humanistic or aesthetic social values and who are aware of the non-native deer at the Seashore would notice the decrease in numbers of fallow deer, in particular, the white color variants of fallow deer. If populations of native black-tailed deer were to increase in number in the areas where fallow deer currently reside, opportunities for viewing deer would not change significantly and visitors with naturalistic or ecologistic social values may experience a slight positive impact. Opportunities to view axis deer would likely increase slightly because of increasing numbers and range, although the vast majority of visitors would not notice any change. Overall, because of changes in deer behavior resulting from the lethal control program, non-native deer viewing opportunities would be fewer and might require more time and effort on the part of the visitor, a long-term, minor adverse impact to the visitor particularly interested in non-native deer viewing. However, the reduction of non-native deer would provide additional habitat for native black-tailed deer, a negligible to minor, long-term benefit to those interested in viewing native ungulates.

Decreased numbers and density of non-native deer grazing in pastoral, wooded and riparian areas could change scenic viewsheds by allowing regrowth of undergrowth vegetation, shrubs and brush. The areas where such changes are most likely to be apparent to visitors are in Olema Valley (from fallow deer). In this area, agricultural grazing is the primary determinant of scenic viewsheds. The contribution which non-native deer make to altering viewsheds is likely to decrease over time with the reduction of non-native deer numbers under this alternative, and would ultimately have a negligible effect on the visitor experience related to viewshed enjoyment.

Under Alternative B, social values of visitors related to lethal removal or use of firearms would also be affected. Visitors with humanistic or moralistic values could experience short-term, adverse effects

ranging from negligible to moderate depending on the visitor and the level of his/her objection to the use of the proposed management method. As mitigation for these potential adverse impacts, Alternative B mandates adherence to rigorous training for all NPS staff or contractors and regular completion of NPS range qualifications specifically designed for ensuring humane and effective wildlife removal. (In addition to other federal contracting requirements, for the purposes of this plan, a contractor is a fully insured business entity; non-profit group or government agency engaged in wildlife management activities that include trapping, immobilization and the lethal removal through sharpshooting and chemical euthanasia. The contractor must possess all necessary permits and be able to pass any needed security clearances.) Consequently, wounding of animals would be minimized, and quick and selective death would be the goal for all targets. In addition, all deer management actions would be conducted in a manner that minimizes stress, pain and suffering to every extent possible.

Under this alternative, the management of non-native deer populations through lethal removal techniques (firearms) is proposed for an indefinite time period. The loss of peace and quiet during shooting operations is another possible adverse impact to the visitor experience. Although this Alternative calls for shooting to take place outside of peak visitation hours, visitors who come to the Seashore for solitude and quiet during non-peak times could be uncomfortable with the noise generated. Temporary area closures for large-scale deer management activities are a possibility with this alternative and may inconvenience some visitors. In addition, management by air could take place, as would monitoring. The noise of overflights would contribute negligibly to a loss of peace and quiet.

A small number of visitors may discover carcasses in the wilderness areas where retrieval by NPS sharpshooters is not possible. Moving any carcass near a heavily used trail to a more remote location to reduce odor problems or conflicts between humans and scavengers would mitigate this impact. Collectively, the impact of firearms use related to soundscape, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in negligible to moderate adverse impacts to the visitor experience. Impacts would be both short-term (individual management actions) and long-term (indefinite duration). The perceived intensity of the impact would depend on the numbers of visitor affected and the duration of each incident's effect.

Wilderness Character

The current unnatural conditions in the wilderness would improve if this alternative is selected. During the life of this plan, and in perpetuity, patches of the wilderness landscape impacted by non-native deer would appear unnatural. Visitors to the wilderness would occasionally encounter NPS staff or contractors, and occasional area closures would impact a few visitors. Also on occasion, noise of firearms and possibly helicopters would mar the natural quiet backcountry users often seek. Based on what is known of visitor use patterns in Seashore wilderness areas, these adverse impacts are estimated to affect fewer than 50 visitors per year.

Wilderness Values

The discussion of wilderness values described above for Alternative A would also apply for Alternative B, as it focuses on the debate between whether humans should manage resources in the wilderness to return a more natural character (biocentric, conservationist values) or limit their intervention either because nature is a better manager (intrinsic, symbolic or spiritual value). In the long term, reducing impacts of non-native deer to natural ecological processes in the Seashore wilderness, albeit only partially, would have minor beneficial impacts to those people with biocentric values. For those who hold ecological views about wilderness, eliminating the impacts of human-introduced species would have minor beneficial effects. For those who hold intrinsic, symbolic or spiritual wilderness values, the intrusion of NPS staff or contractors into wilderness for management would have minor adverse impacts.

Since management would continue in perpetuity, all impacts to wilderness values and character are long-term.

Cumulative Impacts

Cumulative impacts would be the same as those described for Alternative A.

The projects and issues described in the cumulative analysis will have a long-term and beneficial major cumulative impact on visitor experience. This effect of Alternative B is negligible when viewed incrementally with the effects detailed in the cumulative analysis and does not change the overall cumulative effect. However, because Alternative B could also result in some temporary area closures, it would have some additional adverse impacts relative to Alternative A, but these are considered negligible because they would not be detectable by the vast majority of visitors.

Conclusion

This alternative would result in a permanent decrease in fallow deer and an increase in axis deer numbers within the Seashore. Adverse effects from this alternative to the visitor experience related to wildlife viewing; social values including wilderness values; and soundscape/access/visual intrusions are expected to range from negligible to moderate (depending on visitor goals and expectations) and would be both short- and long-term in duration. Negligible to minor, long-term benefits to visitor experiences with naturalistic or ecologistic social values related to wildlife viewing of native deer, as well as to the long term wilderness character in the Seashore, would also be realized under this alternative. When compared to the No Action alternative, Alternative B would result in decreased adverse impacts to viewshed enjoyment and increased opportunities for viewing native deer. At the same time, adverse impacts regarding viewing of non-native deer, visitors with moralistic or humanistic social values, and soundscape preservation/access/visual intrusions are greater under this alternative than that expected under the No Action alternative.

The projects and issues described in the cumulative analysis will have a long-term and beneficial major cumulative impact on visitor experience.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Long-term and short-term
Intensity of Impact:	Negligible to moderate
Cumulative Impact:	Long-term beneficial and major

Impacts on Park Operations

Analysis

The control of a continued but reduced presence of non-native deer would constitute an increase in the scope and extent of current financial and personnel resources necessary to address environmental, social and health and safety concerns. This alternative results in the maintenance of a reduced number of non-native deer in the Seashore in perpetuity, the costs of which would be incurred indefinitely. Operational costs and commitments would be expected to increase from both internal deer control operations and from increased coordination and cooperation outside the park. If continued monitoring by resource management staff warranted a change in deer level goals, the following impacts would increase or decrease accordingly.

Costs related to the monitoring of large populations of non-native deer inhabiting the park are those associated with impacts to natural and cultural resources. In FY 2005, personnel costs for 1.5 FTE (full time equivalents) and the costs of equipment, vehicles, supplies and staff for non-native deer monitoring (including one census yearly) totaled $126,000. Administrative and interpretive costs, excluding the costs of completing this document, likely comprise another $28,000 These costs, currently 2.9 % of the total PRNS annual budget, can be expected to continue at this current level under Alternative B.

Continuing costs to the park of mitigating impacts of non-native deer under Alternative B are unknown and would continue indefinitely as a result of maintaining non-native deer species at the Seashore. These include:

- Costs of disease monitoring and testing in areas of high deer density and where non-native deer are in close contact with livestock.
- Costs of erecting exclosures or deer-proof fencing in areas where high deer densities are adversely impacting sensitive resources, i.e. riparian areas or populations of rare plants.
- Costs of monitoring native species, such as native cervids, songbirds and special status species, adversely impacted by growing non-native deer numbers and range.

The description of Alternative B outlines the likely deer removal numbers based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, Alternative B would require culling of up to 200 fallow deer per year to reduce the population to 350, with up to 75 animals per year removed thereafter. Axis deer, which currently number approximately 250, would not require culling until their numbers surpassed 350. Subsequent removals of up to 40 animals each year would be required to maintain total axis numbers at 350. It should be noted that these numbers are subject to change depending on weather, range conditions and herd growth parameters. Cited figures should be considered approximate guidelines for cost analysis purposes.

The costs of culling 250 deer yearly for the first 3-5 years of the program are estimated to be $187,000/year and include staff expenses (including one full-time biotechnician), training, vehicles, transport, supplies and carcass disposal. Thereafter, costs (before inflation) of removing up to 65 animals per year would be approximately $52,000 per year, in perpetuity.

During the first 3-5 years of the program, costs of controlling non-native deer constitute a 132% increase in funds allocated to non-native deer. After this time, costs of maintaining each species at 350 animals would remain a 36% increase over current levels. See Figure 17 for a comparison of the costs of the alternatives considered.

Estimates for minimum costs for the implementation of Alternative B total approximately $3.5 million by the year 2021. Thereafter, annual costs of $190,000 could be expected indefinitely. The overall costs of implementing Alternative B would constitute 3% – 6% of the total PRNS annual budget, with higher costs occurring within the first 3-5 years of implementation.

Under Alternative B, non-native deer monitoring, mitigation of damage to natural resources caused by non-native deer, and the operation of the culling program would result in adverse impacts to park operations through increased budget expenditures for an indefinite period of time. Because culling operations would continue indefinitely, a permanent increase in operating costs and/or energy use for the park would be long-term in duration. As these increased costs would be greater than 5% of total park budget for the first 3-5 years of implementation, and less than 5% thereafter, adverse impacts are considered moderate in the short-term and minor in the long-term.

Cumulative Impacts

Cumulative impacts would be similar to those described for Alternative A.

Cumulative impacts of Alternative B with the above actions are characterized as adverse, long-term and moderate. Based on potential operating costs for the all projects considered, the staff of the Seashore estimated the cumulative cost of the projects, when viewed incrementally with Alternative B, would be less than $840,000 or 15% or the current operating budget of $5.6 million. Some future operating costs would be offset by fee increases, non-profit assistance, or special grants.

Conclusion

Park operations under Alternative B would be affected as a result of demand on park staff to monitor and mitigate continued impacts to natural resources and to control deer numbers for an indefinite period of time. All of the impacts to park operations associated with the presence of non-native deer are characterized as adverse. Because controlling non-native deer populations indefinitely would represent a permanent increase in operating costs and/ or energy usage for the park, the impacts of Alternative B are considered long-term. Because additions in cost and/ or energy usage would be more than 5% of total park budget for the first 3-5 years of the control program and less than 5% thereafter, the impacts are considered to be moderate in the short-term and minor in the long-term. When compared to the No Action alternative, Alternative B would require a notably smaller (3–6% versus 5–15%) increase in budgetary commitments. However, as under No Action, these expenses would continue in perpetuity, a detriment to park operations.

Cumulative impacts of Alternative B with the above actions are characterized as adverse, long-term and moderate.

Type of Impact:	Adverse
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Moderate (short-term) and minor (long-term)
Cumulative Impact:	Adverse, long-term and moderate

Impacts on Regional Economy

Analysis

Non-native deer have no documented beneficial impacts to the regional economy. Currently there are an estimated 250 axis deer and 860 fallow deer in the Seashore. Alternative B would result in an increase in axis deer and a decrease in fallow deer. Range size would likely increase for axis deer within the Seashore and could decrease for fallow deer. The spread of fallow deer outside of Seashore boundaries would be curtailed.

Impacts of fallow deer to agricultural operations inside and outside of NPS boundaries could be expected to decrease with this alternative. Conversely, expansion of axis deer in the Seashore, as has been reported historically when total axis deer numbers were higher, is expected to lead to increased competition for pasture forage with livestock, damage to fences and depredation of agricultural products (hay and silage).

Currently, these ranchers report that damage to their operations from axis deer includes:
Fence repair costs ($500-$1000/yr per ranch [4 reports])—damage by deer crossings.

Costs of lost pasture forage (unknown costs [4 reports])—pasture forage consumption by non-native deer (refer to detail in the Regional Economy section of Chapter 3, Affected Environment).

These impacts would likely increase in magnitude with growing numbers of axis deer and would be long-term unless target deer levels were lowered in the future. In addition, other ranches, which now are only sporadically inhabited by few axis deer, could be expected to experience increasing impacts of similar types. Under Alternative B, the increase in axis deer could result in minor, long-term adverse impacts to the regional economy related to agricultural endeavors.

Under Alternative B, a smaller fallow deer population size and range would result in an amelioration of current impacts to Seashore ranches where fallow deer are seen year-round in substantial numbers (M, L, and Stewart Ranches), including those related to:

- Costs of lost supplemental feed (unknown costs [1 report])—supplemental food put out for livestock eaten by non-native deer.
- Costs of reseeding pastures ($9000/yr per rancher [1 report])—overgrazing of fallow fields by non-native deer.
- Veterinary costs ($1200 in 2001 [1 report])—leptospirosis (refer to detail in the Regional Economy section of Chapter 3, Affected Environment).

This improvement would last as long as the deer control continued (in perpetuity). Costs of fence repair and lost pasture forage would decrease, as would the monetary impacts of lost supplemental feed, pasture reseeding and veterinary costs. Such effects would represent a minor, long-term benefit for agricultural concerns in and around the park.

Because this alternative might require occasional area closures but no park closures, there would be no effects to local tourist businesses. This alternative would not have significant and disproportionate effects on minority and low-income populations.

Cumulative Impacts

Cumulative impacts would be similar to those described for Alternative A.

Based on the economic statistics discussed in the cumulative analysis, the overall cumulative benefits of the park to the regional economy, when viewed incrementally with Alternative B, are major and beneficial.

Conclusion

This alternative would result in a decrease in fallow deer and an increase in axis deer numbers within the Seashore. The magnitude of impacts to agriculture within and outside of NPS boundaries created from an increased axis deer population is expected to increase over time, resulting in minor, long-term, adverse impacts to the regional economy. At the same time, the reduction of fallow deer numbers under this alternative would reduce agricultural impacts attributed to these deer below the current level—a minor, long-term benefit to the regional economy. Comparatively, the No Action alternative would likely result in a greater number of adverse effects to the regional economy by way of agricultural impacts and potential impacts to low-income farm workers than would Alternative B.

Based on the economic statistics discussed in the cumulative analysis, cumulative impacts are long-term, major and beneficial.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term, major and beneficial

Environmental Consequences of Alternative C – Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control

This alternative would control levels of fallow and axis deer to below carrying capacity, at numbers that would be both logistically sustainable with NPS staff and funding, and would not likely lead to extinction of either species. Techniques used to control deer would include both lethal removal (shooting by NPS staff) and treatment of does with the most effective contraceptive technology available. In the 1970s and 1980s park staff controlled deer to desired levels of 350 of each species. For purposes of analyzing impacts of this action alternative, the same levels (700 total non-native deer) would be assumed. Total numbers of non-native deer would be less than current estimated numbers (approximately 250 axis deer and 1,100 fallow deer) but high densities of deer in certain areas would still be expected because of the tendencies of both species to congregate in large herds. Initially, fallow deer numbers would be controlled by yearly shooting and contraception. In the future, when axis deer numbers surpassed the pre-established limit (for purposes of this analysis, 350), this species would also be culled and individuals would be treated with the most efficient contraceptive technology available. The age, sex, and numbers of deer culled would be determined by resource managers to ensure that populations are maintained at desired levels and to reduce risks of range expansion beyond Seashore boundaries.

The impacts to natural resources and the regional economy do not differ between Alternative B and C. Impacts of Alternative C to park operations, health and human safety and visitor experience differ slightly from those of Alternative B.

Impacts on Water Resources and Water Quality

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to water resources would occur from implementing Alternative C.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed—both short-term and long-term
Intensity of Impact:	Minor to moderate
Cumulative Impact:	Adverse, long-term moderate to major

Impacts on Soils

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to soils would occur from implementing Alternative C.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed—both short-term and long-term
Intensity of Impact:	Minor to moderate
Cumulative Impact:	Adverse, long-term major

Impacts on Vegetation

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to vegetation would occur from implementing Alternative C.

Type of Impact: Adverse
Duration of Impact: Long-term
Intensity of Impact: Moderate
Cumulative Impact: Adverse, long-term moderate to major

Impacts on Wildlife

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, to native species are not different from Alternative B. No impairment to native wildlife would occur from implementing Alternative C.

Although fewer non-native deer would be lethally removed in Alternative C than in Alternative B, pain and suffering would result from lethal removals as well as from fertility control. Some of this pain would be mitigated by use of trained sharpshooters in culling deer. Efforts would be made to deliver immediately lethal shots to target animals. Animals treated with contraceptive agents would undergo the stress of capture, restraint, injection and permanent marking (i.e., radio-collaring and ear-tagging) at least once during their lifetimes. Capture of wild deer would result in unavoidable injuries and some deaths.

Type of Impact: Adverse
Duration of Impact: Long-term
Intensity of Impact: Moderate
Cumulative Impact: Long-term moderate adverse

Impacts on Species and Habitats of Management Concern

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to special status species would occur from implementing Alternative C.

Type of Impact: Beneficial in the short-term, adverse in the long-term
Duration of Impact: Mixed—both short-term and long-term
Intensity of Impact: Minor to moderate
Cumulative Impact: Adverse, long-term and moderate to major (depending on the species of concern)

Impacts on Human Health and Safety

Analysis

Under Alternative C, it is assumed that 75% of the non-native deer actively managed would be culled rather than given contraception and, therefore, the risk of firearm-related injuries to staff and visitors would be noticeably increased over current levels. As culling would continue indefinitely under Alternative C, minor, short-term (transitory, individual culling periods) to long-term (indefinite duration of activity), adverse impacts to staff and visitor safety could result.

Depending on the agent used, Alternative C calls for treatment of up to 25% of fallow does with a long-acting contraceptive or sterilant. Treatment would require capture and immobilization of animals for permanent marking (ear-tagging and radio-collaring). Permanent marking of treated animals would be needed to ensure accurate monitoring of contraceptive effectiveness and to prevent inadvertent culling of treated does. Capture would be accomplished with a corral trap, a drop net, or with a net gun fired from a helicopter. Regardless of the technique used, wildlife capture and immobilization can result in injury to participating staff, either from the animals themselves or from equipment and aircraft. The number of people at risk from capture-related and treatment-related injury under Alternative C depends on the technique used, and is unknown at this time. Because this alternative requires fertility control activities to continue indefinitely, the total number of people at risk of injury during deer capture/treatment is also unknown. Adverse impacts to human safety of minor intensity are expected as a result of capture/treatment actions. Effects are expected to be short-term (transitory, individual capture/treatment incidents) and long-term (indefinite management period) in duration. The reduction of non-native deer numbers and the concomitant effects this may have on deer-vehicle collisions are similar to that described for Alternative B (long-term, minor benefit).

Cumulative Impacts

There are no known cumulative impacts associated with Alternative C when viewed incrementally with the projects and issues listed under Alternative A.

Conclusion

Minor, long- and short-term, adverse impacts to human health and safety for Seashore staff could result from the use of firearms and contraceptive treatments proposed under Alternative C. Minor benefits to public health and safety resulting from reduced risk of deer-vehicle collisions are expected. Compared to the No Action alternative, the implementation of lethal controls and contraceptive operations under Alternative C would result in notably increased risks to human health and safety for an indefinite period of time. At the same time, the No Action alternative would likely represent a slight increase in risk to human safety as a result of potentially increased deer-vehicle collisions when compared to Alternative C.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term adverse and beneficial, minor to moderate

Impacts on Visitor Experience

Analysis

Effects on wildlife viewing of all deer under this alternative are similar to that described under Alternative B (minor, long-term, adverse for non-native deer; negligible to minor, long-term, beneficial for native deer).

Effects on the visitor experience related to viewshed enjoyment under this alternative are similar to those described under Alternative B (negligible).

Under this alternative, the visitor experience is also related to social values, particularly those of attitudes toward animals. Effects of the management techniques proposed (lethal removal/firearms and contraception) under Alternative C could result in adverse effects to the visitor experience to varying degrees and for varying periods of time. These effects are similar to those described under Alternative B (negligible to moderate, short-term, adverse – depending on the visitor and his/her level of objection to the use of proposed methods). As proposed under Alternative C, if contraception proves effective in controlling and maintaining deer populations at specified levels (700), this alternative would represent a less lethal management approach than that proposed under Alternative B (lethal removal only). This less lethal approach has the potential to benefit or adversely affect visitor experience, depending on individual social values. Notably, while only 35% of polled Bay area residents supported lethal control of non-native deer, 65% supported contraception, suggesting fewer visitors would be adversely affected by this alternative than Alternative B. Mitigation measures proposed for this alternative are similar to that described under Alternative B.

Alternative C proposes the management of non-native deer through a combination of lethal controls and contraceptive methods; Alternative B proposes only the use of lethal methods (firearms). While the degree of effect differs slightly, impacts of firearms use related to soundscape, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in effects similar to that described under Alternative B (short- and long-term, negligible to moderate, adverse impacts, depending on the numbers of visitors affected and the duration of each incident's effect). Mitigation measures for such impacts are also similar to those described for Alternative B. In addition, the use of aircraft for monitoring, and for management of deer (shooting, herding into corrals, etc.) would adversely affect the soundscape.

In most ways, impacts to the wilderness character and values for Alternative C would be the same as for Alternative B (mixed, minor and long-term). In addition, some visitors, especially those searching for a "wilderness experience" in the Seashore, might object to seeing permanent marks such as radio collars and eartags on fallow does treated with contraceptives. Because the population control techniques in Alternative C would be used in perpetuity to maintain a target number of non-native deer populations, resulting visitor experience impacts would be long-term, minor, and adverse for those who find them offensive.

Cumulative Impacts

Cumulative impacts under Alternative C are similar to those described for Alternative B.

Conclusion

This alternative would result in a permanent decrease in fallow deer and an increase in axis deer numbers within the Seashore. Adverse effects from this alternative to the visitor experience related to wildlife viewing; social values; soundscape/access/visual intrusions; and wilderness experience are expected to range from negligible to moderate (depending on visitor goals and perceptions) and would be both short- and long-term in duration. Negligible to minor, long-term benefits to the visitor experience related to viewing of native deer are also possible under Alternative C. Compared to No Action, adverse impacts to social values, soundscape preservation/access/visual intrusions, and wilderness experience would be increased under Alternative C. Conversely, opportunities for viewing of native deer are increased under this alternative when compared to No Action.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Long-term and short-term
Intensity of Impact:	Negligible to moderate
Cumulative Impact:	Long-term beneficial and major

Impacts on Park Operations

Analysis

As in Alternative B, the impacts of continued presence of non-native deer would constitute an increase in the scope and extent of current financial and personnel resources necessary to address environmental, social and health and safety concerns. This alternative results in the maintenance of a reduced number of non-native deer in the Seashore in perpetuity, the costs of which would be incurred indefinitely. Operational costs and commitments would be expected to increase from both internal deer control operations and from increased coordination and cooperation outside the park. If continued monitoring by resource management staff warranted a change in deer level goals, the following impacts would increase or decrease accordingly.

Actions associated with monitoring of non-native deer and mitigation of deer impacts to natural resources under Alternative C are similar to those described under Alternative B.

Chapter 2 outlines the likely deer removal numbers under Alternative C, based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, Alternative C would require culling of up to 50% of fertile fallow females per year along with treatment of up to 25% of does per year with a long-lasting contraception to reduce the population to 350. Thereafter, up to 20 animals per year would be removed and treated. Axis deer, which currently number approximately 250, would not require culling or treatment until their numbers surpassed 350. Subsequent removals of 25-40 animals per year would be required to maintain total axis numbers at 350. Should a long-lasting contraceptive be developed for axis deer, numbers culled could decrease as axis does were treated. It should be noted that all of these numbers are subject to change depending on weather patterns, range conditions and herd growth parameters. Cited figures should be considered approximate guidelines for cost analysis purposes.

During the reduction phase of the control program, costs of culling up to 180 deer yearly include staff (including one full-time biotechnician), training, vehicles, transport, supplies and carcass disposal, and are estimated to be $135,000 per year. Thereafter, during the maintenance phase of the control program, costs (before inflation) of removing up to 45-60 animals per year could reach $45,000 per year in perpetuity.

Because there is currently no long-duration contraceptive registered for management of deer with the EPA, any drug used by NPS would likely require experimental research. Costs of such research are difficult to predict but would likely exceed usual management costs. Research requires collection of data on survival and fawning rates of treated and control deer through radio telemetry, fawn counts and necropsies. Additional studies on health effects and safety of the experimental drug may be required by EPA. The costs of giving contraception to deer also depends on the duration and effectiveness of the chosen agent and can only be approximated. An NPS proposal for a one-time administration of up to 70 fallow does was estimated to cost $148,000 or $2,100 per treated deer (NPS unpublished proposal, PMIS# 97426). Should GonaCon® prove effective in preventing reproduction for the life of fallow does, Hobbs' estimate of 176 does requiring treatment to control the population at 350 by 2021 would cost a minimum of $400,000. Thereafter, treatment of up to 25-50 does periodically (every 4-8 years, indefinitely) would cost at least $105,000 per treatment period.

During the first 3-5 years of the program, costs of controlling non-native deer with culling and long-lasting contraception constitute a 300% increase in funds currently allocated to non-native deer and between 3% and 12% of the total Seashore budget. After this time, costs would remain a 25-100% increase over current levels, and up to 5% of the total Seashore budget, depending on the extent to which contraception is used to maintain each species at 350 animals. See Figure 17 for a comparison of the costs of the alternatives considered.

Estimates of minimum costs for the implementation of Alternative C total approximately $3.6 million by the year 2021. Thereafter, annual costs of greater than $200,000 could be expected indefinitely. The costs of implementation of Alternative C would constitute an increase of 3-12% of the total PRNS budget.
Under Alternative C, non-native deer monitoring, natural resource damage mitigation, and deer culling and contraception operations could result in long-term, moderate, adverse impacts to park operations at PRNS resulting from increased financial commitments over an indefinite period of time.

Cumulative Impacts

Cumulative impacts of Alternative C are similar to those described under the No Action alternative.

Conclusion

Alternative C proposes the maintenance (lethal removal and contraception) of axis and fallow deer at specified levels indefinitely. In addition to cumulative Impacts, park operations under Alternative C would be adversely affected as a result of demand on park staff to monitor and mitigate continued impacts and to control deer numbers for an indefinite period of time. Because additions in cost and/or energy usage for non-native deer management would likely be more than more than 5% of total park budget indefinitely, the impacts are considered to be moderate and long-term. When compared to the No Action alternative (5–15% budget increase), Alternative C would require a relatively similar increase (3–12%) in budgetary commitments for an indefinite period of time.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate
Cumulative Impact:	Adverse, long-term and moderate

Impacts on Regional Economy

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative B.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term, major and beneficial

Environmental Consequences of Alternative D: Removal of All Non-Native Deer by Agency Personnel

This alternative would remove all fallow and axis deer from PRNS and PRNS–administered lands in 15 years. It is expected that large numbers of deer would be removed during the first 5 years of the program and that, because of increased wariness on the part of the deer and lower deer densities, a more gradual decrease over the next 10 years would follow. An effort would be made to remove deer in a manner that did not lead to increased migration outside of NPS boundaries, and it is expected that this alternative would not result in increased numbers of non-native deer on state park or private adjacent lands. However the Vedanta property, which currently contains the highest fallow deer densities in Olema Valley (up to 80 deer/sq. km.), is outside of NPS management jurisdiction and surrounded entirely by NPS lands. It is likely that during the removal program in the Seashore, deer densities on this inholding would increase.

Impacts on Water Resources and Water Quality

Analysis

Potential consequences of non-native deer eradication are reduced concentrations of animals adjacent to and within streams, ponds, and lakes. Fallow deer, typically found in large herds, tend to remain in areas for long periods of time. This behavior results in major denudation of the area around the herds. In addition, fallow deer tend to return to the same locations annually, resulting in long-term degradation of areas. Alternative D would reduce and eventually eliminate this degradation, allowing regrowth of riparian vegetation.

As noted in other sections (see Impacts of Alternative A to water resources and water quality, for example), fallow deer also impact water quality by eliminating riparian vegetation during the rut, when the bucks tend to aggressively rub and thrash their antlers. Impacts of fallow deer grazing and thrashing are most acute within the pastoral zone in Olema Valley, where many riparian areas have been deliberately excluded from livestock grazing to restore canopy and natural hydrologic processes. In these areas, revegetation efforts and natural regrowth have been severely retarded due to heavy grazing and antler rubbing by the non-native deer (B. Ketcham, NPS, personal communication). Continual grazing of new shoots and seasonal thrashing by fallow deer prevents native riparian plants from growing beyond shrub height.

Within NPS boundaries, Alternative D would quickly result in localized beneficial impacts to hydrologic processes (associated with streambank breakdown and erosion), aquatic habitat (associated with excess delivery of sediment to the aquatic resources and impact to riparian vegetation and growth rates), and water quality (both sediment and nutrient related). In the long-term, non-native deer eradication could result in moderate or readily apparent beneficial impacts on hydrologic process, aquatic habitat, and water quality in the Seashore compared to Alternative A.

Because it would be a safe zone, deer populations could expand into private inholdings within Seashore boundaries, such as the Vedanta property in Olema Valley when agency shooting begins. Increased fallow deer densities around riparian areas in this vicinity could cause short-term, minor to moderate adverse impacts to hydrologic processes, aquatic habitat and water quality. In the long-term, eventual eradication of fallow deer in the Olema Valley would reverse these impacts and allow natural restoration of these areas.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil erosion and potential for increased sedimentation of waterways. Alternative D specifies that NPS staff would attempt

to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country use of vehicles would rarely be used, particularly in wilderness and sensitive areas, adverse impacts to water resources from sedimentation resulting from this alternative are considered short-term and insignificant.

Cumulative Impacts

Cumulative impacts are the addition of those impacts of the alternative to those already existing or predicted to exist in the near future. Because all adverse impacts to water resources associated with non-native deer would be eliminated in this alternative by 2021, beneficial cumulative impacts of non-native deer eradication would occur by the end of the planning period. However, up until that point, cumulative impacts to water would be similar to those described for Alternatives A-C, and would result from the non-native deer (adverse) along with ongoing ranching (adverse), prescribed burning and thinning under the Fire Management Plan (beneficial), sewage treatment system additions and upgrades (beneficial), and water quality, wetlands and fish restoration projects (beneficial). As non-native deer numbers decrease with time, the beneficial impacts of some the above described projects would increasingly offset the diminishing adverse impacts of fallow and axis deer to water resources. Cumulative impacts of Alternative D, when viewed incrementally with the various restoration projects above, would result in long-term beneficial impacts except with regards to continued ranching, which would result in continued adverse moderate to major impacts to water resources.

Conclusion

No impairment to water resources would occur from implementing Alternative D. Both short-term and long-term impacts to water resources within the Seashore are characterized as beneficial and moderate. Impacts to the water resources in the Vedanta inholding are characterized as adverse and minor in the short-term because of the likely temporary increase in deer densities on the property during the initial stages of the removal program. In the long term, water resources in the Vedanta property, like those within the Seashore, would benefit to a moderate extent from non-native deer eradication since current impacts to hydrologic processes, aquatic habitat and water quality would be removed. Cumulative impacts of Alternative D, because they are considered incrementally with projects that have both adverse and beneficial long-term impacts to water resources, are considered mixed.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor adverse in the short term, moderate beneficial in the long-term
Cumulative Impacts:	Minor to moderate adverse in the short term; beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Soils

Analysis

As noted in other sections of this document, non-native deer have the potential to increase erosion and soil compaction, particularly where they are congregated in large herds for long periods of times. Fallow and axis deer consume vegetation, trample and destroy it, and increase compaction of soils. Compaction in turn results in increased runoff and reduced infiltration. In combination with soils unanchored by root structures, increased erosion results under these conditions. Fallow and axis deer also increase bare ground in areas they occupy by rutting behaviors and by creating trails. Each of these behaviors has

resulted in denuded areas, which are eroded during the fall and winter rainy season at the Seashore. Alternative D would reduce and eventually eliminate this degradation allowing regrowth of riparian vegetation.

Short-term movement of deer populations into private inholdings within Seashore boundaries, such as the Vedanta property in Olema Valley, could result from NPS shooting operations. Increased fallow deer densities in the Vedanta Society property, causing increased trailing, compaction and erosion are possible short-term impacts from deer removals in the Seashore. In the long-term, eventual eradication of fallow deer in the Olema Valley would reverse these impacts and allow natural restoration of soils in Vedanta.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil compaction. Alternative D specifies that NPS staff would attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country vehicles would rarely be used, particularly in wilderness and sensitive areas, adverse impacts to soils from compaction resulting from this alternative are considered short-term and insignificant.

Substantial benefits would occur to park soils, as well as to regional soils compared to Alternative A if non-native deer were eradicated. Alternative A would almost certainly result in expanded herds outside of the Seashore, with regional, major impacts to soils similar to those experienced currently on a localized basis inside the park. Although localized minor impacts to soils at the Seashore would continue for a period of time until eradication is complete or near complete, in the long-term soils would no longer experience impact from non-native deer. Because impacts to soils are not yet severe, over time it is likely that vegetation would regrow in bare or compacted soils.

Cumulative Impacts

Because all adverse impacts to soil associated with non-native deer would eventually be eliminated in this alternative, incremental additive impacts to soils would also eventually be gone. However, up until that point, cumulative impacts would be similar to those described for Alternative A. These include denuding and resulting erosion from continued livestock operations, past development inside and outside of the park and historic logging. Current or future planned changes to buildings inside the Seashore would not likely result in disturbance of soils, although the restoration of the Giacomini property to re-create coastal marsh would involve the movement and disposal of agricultural related soils and manure. As non-native deer numbers decrease with time, the beneficial impacts of some the above described projects would increasingly offset the diminishing adverse impacts of fallow and axis deer to soils. Cumulative impacts of Alternative D, when viewed with the various restoration projects above, would result in long-term beneficial impacts except with regards to continued ranching, which would result in continued adverse moderate impacts to soils.

Conclusion

No impairment to soils would occur from implementing Alternative D. Both short-term and long-term impacts to soil within the Seashore are characterized as beneficial and moderate. Impacts to soil resources in the Vedanta inholding are characterized as adverse and minor in the short-term because of the likely temporary increase in deer densities on the property during the initial stages of the removal program. In the long term, soil in the Vedanta property, like those within the Seashore, would benefit to a major extent from non-native deer eradication since current compaction and erosion would be alleviated. Cumulative impacts of Alternative D, because they are considered incrementally with projects that have both adverse and beneficial long-term impacts to soils, are considered mixed.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor adverse; moderate beneficial
Cumulative Impacts:	Minor to moderate adverse in the short term; beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Vegetation

Analysis

As noted in the impact analysis of Alternative A, non-native deer can have a multitude of impacts on vegetation inside the park. These include consumption, compaction of soils, and loss of vegetation from trampling, rutting behavior, and breaking trails. Deer can affect the physical structure of vegetative communities, species composition, species richness and the level of nutrients through browsing and the addition of nutrients in the form of feces and urine. Deer can also adversely affect unique vegetative communities or consume species that are unique or protected. In the Seashore, fallow deer have had severe localized effects on riparian vegetation. Axis and fallow deer also eat some of the same foods as native deer and elk in the park, and so may have a cumulative adverse effect on plant species. Because these impacts occur on over 120 acres of the park, they are currently considered major in intensity. The continuation of current management practices (e.g., adoption of Alternative A) would result in expansion of the herd and the spread of these impacts to vegetation across the region, with more widespread and major impacts.

Alternative D would remove fallow and axis deer and over time and would eliminate the ongoing impact they have had on park vegetation. The impacts occur in a large area, but it is likely that most would be restored over time. For example, fencing that has been successful in keeping cattle out of areas where no fallow deer graze has resulted in the restoration of riparian vegetation. If current impacts from non-native deer are similar to those caused by cattle, restoration within a few years of their eradication is likely, even in highly disturbed riparian areas. It is possible that populations of native deer would increase following the eradication on non-native deer. If so, impacts across the park from their browsing may continue at a negligible or minor level, although the concentrated occupation of riparian habitat is not likely to occur.

Alternative D would result in both short and long-term moderate to major localized beneficial impacts to vegetative processes (associated with plant establishment and regrowth), habitat (associated soil erosion and plant growth rates), and plant diversity (associated with preferential grazing and browsing). It would also offer substantial benefits relative to Alternative A by eliminating the risk of non-native species expanding their range to areas outside the Seashore.

A short-term influx of non-native deer populations into the Vedanta Society property from NPS lands, as a result of the lethal removal program, could cause minor adverse impacts to riparian vegetation there. With ultimate eradication of fallow deer in Olema Valley, these impacts would be reversed and restoration of affected areas would eventually occur.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor direct destruction of vegetation. Alternative D specifies that NPS staff would attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because vehicles would rarely be used off-trail, particularly in wilderness and sensitive areas, adverse impacts to vegetation resulting from this alternative are considered insignificant.

Cumulative Impacts

Over the long term, managed populations of non-native deer would reduce concentration-associated impacts to vegetation at the Seashore. This alternative may also improve the success and effectiveness of plant conservation and restoration projects due to the elimination of grazing and thrashing pressure by non-native deer on individual rare species and recovering native vegetation. Until the beneficial effects on vegetation of eliminating non-native deer are fully realized, adverse effects of their presence would continue as described for the cumulative effects section in Alternative A. These effects include trampling, loss and denudation both from the deer themselves and efforts to eradicate them. Other activities such as grazing by native deer and cattle (adverse impacts), continued cattle operations (adverse impacts), and the beneficial effects of fire management activities and fencing to exclude livestock from sensitive riparian areas would have short term incremental effects. As non-native deer numbers decrease with time, the beneficial impacts of some the above described projects would increasingly offset the diminishing adverse impacts of fallow and axis deer to vegetation. Cumulative impacts of Alternative D, when viewed incrementally with various restoration projects, would result in long-term beneficial impacts except with regards to continued ranching, which would result in continued adverse moderate impacts to vegetation. When non-native deer have been eradicated, beneficial cumulative effects on vegetation would occur although continued adverse impacts, ranging from moderate to major in intensity, would persist from ranching.

Conclusion

No impairment to vegetation would occur from implementing Alternative D. Based on current and past data on fallow and axis deer, eliminating non-native deer from the Seashore would positively affect vegetation communities within over 52,191 acres of current fallow deer range and over 1,500 acres of current axis deer range. Based on current reports of damage to riparian and understory vegetation within the Seashore, the magnitude of current impacts to vegetation within NPS boundaries are currently moderate to major in intensity. Consequences of alleviating these impacts with the actions described in Alternative D would be beneficial, moderate and long-term to Seashore vegetation. Impacts to vegetation on the Vedanta Property would be adverse and minor in the short-term and beneficial and major in the long-term. Substantial benefits to vegetation outside the park relative to Alternative A are likely from eliminating the risk of non-native species expanding their ranges. Cumulative impacts of Alternative D, because they are considered incrementally with projects that have both adverse and beneficial long-term impacts to vegetation, are considered mixed.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor adverse and moderate beneficial
Cumulative Impacts:	Minor to moderate adverse in the short term; long-term, moderate to major, beneficial and moderate adverse cumulative impacts (after non-native deer are eradicated)

Impacts on Wildlife

Analysis

For this analysis, the best professional judgment of wildlife biologists, as well as research completed at the Seashore and elsewhere, have been used to determine impacts of eradicating fallow and axis deer

populations on other wildlife species. In general, eventual disappearance of non-native deer would have beneficial impacts to other wildlife species in the Seashore.

Non-native Cervids

Agency culling of non-native deer would adversely impact axis and fallow deer by removing reproducing animals from the population. In looking at the fallow population model developed by Gogan et al. (2001), culling a total 1,500 fallow deer and 700 axis deer would eradicate both species in 15 years (see Appendix B for an explanation of the model). Total numbers culled depends on the sex and age of removed animals as well as the carrying capacity of their habitat and density dependent pressures on the herds.

Alternative D, because it results in shooting of non-native deer, would cause a measure of pain and suffering to culled animals. The degree of pain and suffering would be mitigated by use of trained agency sharpshooters for all control operations. Efforts would be made to deliver immediately lethal shots to target animals and sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

Native Cervids

In their study of axis and fallow deer introductions nationwide, Feldhammer et al. (1993) stated:

> "We may expect competition between exotic and native artiodactyls both intuitively, and on the basis of previous field experiments with a variety of animal groups from various trophic levels and habitats…."

Native black-tailed deer are primarily browsers while both axis and fallow deer have been shown to be grazers. Studies at PRNS have demonstrated however that, during times of low forage availability, non-native deer adapt their feeding habits and consume larger amounts of forbs and browse (Elliott 1983; Elliott and Barrett 1985). One researcher estimated that at current levels of non-native deer, there is a 46% reduction in black-tailed deer, a major adverse impact (Fellers 2006). Decreasing numbers of non-native deer would result in decreased competition with native black-tailed deer for forbs and browse during droughts, at the end of summer, and year-round on poor quality ranges (Connolly 1981; Elliott 1983; Fellers 1983). Decreased competition for limited forage would result in improved condition in black-tailed deer (Brunetti 1976; Fellers 1983). Decreased competition for forage would likely result in improved black-tailed doe fertility, increased fawn production and higher fawn survival over current levels. The magnitude of the beneficial impacts to black-tailed deer populations would depend on range conditions and precipitation patterns but would likely be major and could be expected to last longer than two breeding cycles.

Biologists in New Zealand documented that established, high-density populations of fallow deer competitively excluded red deer (*Cervus elaphus scotticus*), an elk species native to Europe (Challies 1985). Red deer are considered the most widespread and successful of all deer species introduced to New Zealand except where their range overlaps with previously established fallow deer populations (Challies 1985). Decreased densities of fallow deer in areas of the Seashore where free-ranging tule elk inhabit would likely allow expansion of the elk herd.

Tule elk, like fallow and axis deer, are primarily grazers. Grasses constitute a large proportion of the diets of all three species year-round (Elliott and Barrett 1985; Gogan and Barrett 1985; Fallon-McKnight unpublished data). In addition to allowing further expansion of tule elk herds, lower numbers of non-native deer could beneficially impact current elk populations in the Seashore through decreased

competition for forage (Brunetti 1976). Such impacts would be reflected in higher elk calving rates, earlier onset of reproduction in tule elk cows and improved elk calf survival.

Direct behavioral competition between fallow deer and tule elk currently exists at PRNS and would likely decrease with Alternative D. Researchers in the Zehusice Deer Park in the Czech Republic have documented behavioral exclusion of red deer by fallow deer at high-density feeding sites (Bartos et al. 1996). Fallow deer at Zehusice were observed to: (1) be consistently more aggressive than red deer, (2) preferentially seek out feeding sites where red deer congregated, and (3) attack red deer from the rear as a strategy to overcome their larger opponents (Bartos 1996). In the Tomales Point Elk Reserve at PRNS, fallow bucks have been observed sparring with tule elk bulls (PRNS unpublished data (m)). In all observed instances, fallow bucks were successful in chasing away elk bulls in spite of a substantial size disadvantage. The consequences of decreased behavioral competition are difficult to predict with certainty but could include expansion of elk into higher quality forage or habitats, improved condition of reproducing adults and ultimately, increased population growth, or population stabilization.

Paratuberculosis, or Johne's disease, is an infectious and incurable diarrheal wasting disease of wild and domestic ungulates. In a study conducted at PRNS in 1979, paratuberculosis was documented in 9.6% and 8.1% of axis and fallow deer, respectively (Riemann et al. 1979b). The disease has been documented in tule elk at Tomales Point Elk Reserve since 1980 but has never been found in PRNS black-tailed deer (Jessup et al. 1981; Sansome 1999 unpublished report). In 1998-1999, relocation of 45 adult tule elk from Tomales Point to the Limantour wilderness area included a 6-month quarantine and extensive testing for Johne's disease (Manning et al. 2003). Only those animals that consistently tested negative on all blood tests and fecal cultures were released in July 1999 to form a new free-ranging herd. This elk herd is currently made up of 34 animals. The goal of the relocation was to restore the dominant native herbivore to the Seashore's wilderness ecosystems.

Transmission of the organism that causes paratuberculosis (*Mycobacterium avium ss. paratuberculosis*) occurs primarily from infected adults to young animals. The period of greatest susceptibility for this infection appears to be the first 6 months of life. The organism is shed by infected animals into feces that may contaminate feed, water, and pastures. The prevalence of the infection and the incidence of clinical disease may climb when an affected population approaches carrying capacity. At these high densities, affected herds experience the stressors of reduced forage nutritional quality and reduced ability to fight disease. This immunosuppression can result in increased transmission of infections, heavier parasite loads and progression to clinical illness. (Manning et al. 2003). Animals in the clinical phase of Johne's disease shed the organism more often and in greater numbers. Premise contamination with this hardy and long-lived organism may thus increase, a factor relevant to the health of numerous species. All cervids are believed to be susceptible to this infection (Manning and Collins 2001).

As noted in the analysis of other action alternatives, newly discovered ectoparasites on fallow and axis deer pose an unknown but potentially significant risk of disease to native black-tailed deer and tule elk. Of most concern is *Bovicola tibialis*, a chewing louse typical of fallow deer, but not native to either black-tailed deer or tule elk. USDA researchers are concerned that this parasite may transfer from fallow deer to native cervids and cause disease, pediculosis. Serious pediculosis outbreaks are associated with the exposure of a previously unexposed population to a new or exotic parasite and are a concern for PRNS native deer and elk, as are the associated possible increases in morbidity, mortality and reduced recruitment of young.

Alternative D would result in lower densities, and the eventual elimination of non-native deer in PRNS and outside of NPS boundaries. Because non-native deer could scatter into smaller herds as a result of the culling program, the prevalence of paratuberculosis and pediculosis (louse infestation) would decrease in

these herds and the potential for transmission to tule elk and black-tailed deer that share their habitat with these smaller herds would decrease.

Genetic variability assists populations in adapting to environmental changes and reduces vulnerability to catastrophic events such as disease, abnormal weather cycles, pollution etc. Fewer than 4,000 of the 500,000 tule elk historically present in California currently remain. Tule elk at PRNS have passed through four severe population reductions or "bottlenecks." With each bottleneck, the amount of genetic variability in the population has been reduced. It has been estimated that PRNS elk are among the most inbred in California, with a degree of relatedness equivalent to that resulting from three consecutive brother-sister matings (McCullough et al. 1996). Physical signs of inbreeding, such as cleft palate, have been observed in the Tomales Point herd (Gogan and Jessup 1985).

Management techniques to increase genetic diversity within and among wildlife populations include: (1) translocating animals between subpopulations, and (2) increasing the number of reproducing animals within each subpopulation (McCullough et al. 1996). For the past 5 years, NPS has cooperated with California Department of Fish and Game to transfer adult elk cows to Tomales Point, in order to increase genetic variability. One of the primary goals of the PRNS General Management Plan is to maintain viable populations of tule elk in the Seashore and to restore free-ranging elk to wilderness ecosystems. Alternative D would likely accelerate the growth of the free-ranging tule elk herd. Greater numbers of breeding animals would result in higher genetic variability and decreased risk of catastrophic population downswings.

Alternative D would result in:

- increased tule elk and black-tailed deer food availability;
- increase in tule elk and black-tailed deer numbers;
- increased tule elk range; and
- increased genetic variability within a the PRNS tule elk population.

Impacts to native cervids from Alternative D inside and outside of NPS boundaries would be beneficial, moderate to major, depending on the species, and long-term.

Small Mammals

The impacts of decreased non-native deer populations on small mammals would occur in two ways: (1) by habitat alteration, influencing food supply and cover, and (2) by direct, beneficial, competition for resources, mainly, food (Flowerdew and Ellwood 2001). In order to definitively demonstrate impacts of diminishing deer populations on small mammals at PRNS, large-scale deer exclosure experiments would have to be used to investigate responses at varied deer densities. Such experiments have not been carried out at PRNS and are discussed in Chapter 2 (in the Alternatives and Actions Considered but Rejected section). Impacts to small mammals are extrapolated from research completed in the U.S. and in the U.K. on fallow deer and white-tailed deer in lowland woodlands (Putman 1986; McShea 2000; Flowerdew and Ellwood 2001; Fuller 2001). Inventories of small terrestrial vertebrates, conducted at PRNS from 1998-2001 in the agricultural and ungrazed areas of the Seashore, were also considered in this analysis (Fellers and Pratt 2001).

In the Britain, heavy grazing pressure (100 deer/sq. km.) by fallow deer in lowland forests caused reductions and even local extirpations of wood mice, bank voles and common shrews (Putman et al. 1989). The loss of palatable ground-level vegetation removes food sources for small herbivores and at the same time, changes microclimates and reduces protection from predators (Flowerdew and Ellwood 2001). Increased browsing of shrubs in forested habitat or on forest-grassland interfaces, as has been

demonstrated in both axis and fallow deer at the end of summer and during droughts (Elliott 1982), has likely altered suitability of those areas for some species. High densities of fallow deer have been observed to alter riparian cover and vegetation at PRNS through browsing and antler thrashing (B. Ketcham, NPS, personal communication). Reducing such impacts with Alternative D could increase cover and habitat for dusky-footed woodrat (*Neotoma fuscipes*).

Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). Densities of fallow deer in the Olema Valley areas of PRNS currently approach 80 deer/ sq. km. (NPS 2002a) and could be expected to decrease in Alternative D. Grazing pressure from deer in many Olema Valley sites is currently considered heavy. Should this grazing pressure decrease with Alternative D, species that could benefit are the: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*). Decreased fallow deer densities and range resulting from Alternative D would likely increase habitat for these species in limited areas of the Seashore, for longer than 2 breeding cycles. The beneficial impacts could therefore be considered moderate and long-term.

Not all species decline with increasing deer grazing pressure. Grazing at intermediate and low deer densities has been shown to increase or have no effect on some plant and animal species in Britain (Fuller and Gill 2001). At PRNS, deer mice (*Peromyscus maniculatus*) were found more often in pastures grazed by cattle than in pastures where cattle were excluded (Fellers and Pratt 2002). It is possible that with decreased deer grazing pressure in PRNS, deer mouse abundance would decrease. Other small mammal species that thrive in open grassland environments, such as the Valley pocket gopher (*Thomomys bottae*), could also remain unaffected or decrease.

Direct competition for food between non-native deer and small mammals is a potential adverse short-term impact resulting from Alternative D. In the absence of definitive data from park exclosure experiments, evidence of dietary overlap between species has been evaluated. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996; Jurek 1977). In addition, analyses of fallow and axis rumen and fecal samples have shown heavy use of many of the same species used by small mammals (Elliott 1982; Fallon-McKnight 2006). Small mammals likely to benefit from decreasing competition for food are the: Pacific jumping mouse (*Zapus trinotatus*), California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus)*, western harvest mouse (*Reithrodontomys megalotis*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*).

Depending on local deer densities, weather patterns and the yearly mast crop, relative beneficial impacts to small mammals from Alternative D range from minor to moderate throughout the Seashore. Because they persist for longer than 2 breeding cycles, impacts are considered long-term.

Mammalian and Avian Predators

This category includes wildlife species, such as mountain lions (*Felis concolor*), coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), badgers (*Taxidea taxus*), weasels (*Mustela spp.*) and the raptors that prey on small mammals.

Although no research at PRNS has been conducted to document the extent to which non-native deer are preyed upon by carnivores, anecdotal and historical evidence suggest low-level predation, especially on fawns. Since their introduction in the 1940s, there has been a decrease in the proportion of observed white

fallow deer, from 75% to 21%, suggesting that white individuals may be preferentially selected by predators (Wehausen 1973; NPS 2002a). An anecdotal report exists of an axis doe defending her fawn from a bobcat (NPS unpublished data (n)). Ranchers have reported coyotes preying on axis fawns in the pastoral zone (N. Gates, NPS, personal communication). However, because non-native deer congregate in large groups and prefer open habitat, it is unlikely that they serve as a primary prey base for native mega- and meso-carnivores that specialize on stalking black-tailed deer and small mammals. Alternative D would decrease the non-native deer prey base for mountain lions, coyotes and bobcats. This beneficial impact would likely be offset by an increase in both the black-tailed deer and small mammal prey base for these carnivores, foxes, weasels and badgers.

In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls (*Strix aluco*) and kestrels (*Falco tinnunculus*), especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely beneficial impact on their rodent prey base, Alternative D would benefit birds of prey such as great-horned owls (*Bubo virginianus*), short-eared owls (*Asio otus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), red-shouldered hawks (*Buteo lineatus*), red-tailed hawks (*Buteo jamaicensis*), Northern harriers (*Circus cyaneus*), black-shouldered kites (*Elanus caeruleus*), sharp-shinned hawks (*Accipiter striatus*) and Cooper's hawks (*Accipiter cooperii*).

Overall, the beneficial impacts of Alternative D to predators in the Seashore and in Marin County would be moderate and long-term.

Other Birds

Little is known about the impacts of grazing wildlife on birds in the Seashore. In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle to ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Only one species, the savannah sparrow (*Passerculus sandwichensis*), was found in higher numbers in grazed grasslands.

Deer exclosure studies in Pennsylvania hardwood forests indicate that high densities of white-tailed deer (*Odocoileus virginianus*) cause declines in intermediate canopy-nesting songbirds. This study showed complete absence of certain songbird species, including American robins (*Turdus migratorius*), at deer densities over 25 deer/ sq. km.(deCalesta 1994). These declines are thought to occur because high deer numbers alter the structure of woody and herbaceous vegetation 0.5–7.5 meters above the ground (deCalesta 1994). Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests suggested that some bird species, namely understory nesters, declined with high deer grazing pressure while other species, namely bark foragers, benefited from reductions in understory vegetation. Researchers in British lowland forests determined that "losers" substantially outnumbered "winners" and that breeding populations of migrant birds were especially vulnerable to adverse impacts from heavy deer grazing pressure (Fuller 2001).

Table 11 lists the ground or low nesting bird species (nesting at approximately 0.3–3 meters) found in the Seashore. These species are found in habitats where the greatest impacts from large herds of non-native deer currently would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). It is likely that Alternative D would cause an increase in abundance of low nesting species that depend on understory vegetation to place their nests. Impacts on reproductive success and survival are unknown. It should be noted that Table 11 primarily contains species breeding at PRNS and GGNRA and is not exhaustive. Two species that would likely be impacted, the San Francisco common yellowthroat (*Geothlypis trichas sinuosa*) and the California Swainson's thrush (*Catharus*

ustulatus oedicus) are not listed in this table because they are either California Bird Species of Special Concern (CDFG) or Birds of Conservation Concern (USFWS) and are discussed in the Impacts on Species and Habitats of Management Concern section.

TABLE 11: BIRD SPECIES LIKELY TO BENEFIT FROM ALTERNATIVE D. (T. GARDALI, POINT REYES BIRD OBSERVATORY, PERSONAL COMMUNICATION, SHUFORD AND GARDALI, IN REVIEW)

Common Name	**Scientific Name**
Allen's hummingbird	*Selasphorus sasin*
American goldfinch	*Carduelis tristis*
Bewick's wren	*Thryomanes bewickii*
Brewer's blackbird	*Euphagus cyanocephalus*
California towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Marsh wren	*Cistothorus palustris*
MacGillivray's warbler	*Oporornis tolmiei*
Orange-crowned warbler	*Vermivora celata*
Oregon junco	*Junco hyemalis thurberi*
Red-winged blackbird	*Agelaius phoeniceus*
Spotted towhee	*Pipilo maculatus*
Western meadowlark	*Sturnella neglecta*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*

It is expected that overall avian species richness, abundance and diversity would increase measurably with reduction of the heavy grazing pressure resulting from Alternative D. Adverse impacts to a few grassland species would be offset by larger benefits to relatively more species that depend on understory shrub layers for nesting, especially in the riparian and woody-grassland interfaces currently impacted by high densities of non-native deer. The beneficial impacts to various species would be moderate and long-term within the Seashore.

Reptiles and Amphibians

PRNS has some information on the impacts of large herds of grazing herbivores on reptiles and amphibians in the Seashore. During inventories of small vertebrates conducted at PRNS in 2001, northern alligator lizards (*Gerrhonotus coeruleus*) were not found in pastures grazed by cattle but were found in similar ungrazed sites (Fellers and Pratt 2002). Changes to woodland understory vegetation, especially in riparian areas, as has been documented with high densities of fallow deer at PRNS, would alter microclimates and habitats for frogs, lizards and salamanders. Adverse impacts under current non-native deer densities could be expected for alligator lizards, California slender salamanders (*Batrachoseps attenuatus*), rubber boas (*Charina bottae*), western skinks (*Eumeces skiltonianus*), racers (*Coluber constrictor*), garter snakes (*Thamnophis elegans)*, and Ensatina salamanders (*Ensatina eschscholtzii*). By

allowing regrowth of understory vegetation with reduced deer densities, Alternative D would benefit these species.

Because of expected mild to moderate beneficial impacts of Alternative D on small mammal abundance (see above), concomitant increases can be expected in reptiles that prey on shrews and rodents. Species in this category are the: western terrestrial garter snake, rubber boa, and gopher snake (*Pituophis melanoleucus*).

Studies of British lowland forests heavily grazed by fallow deer have shown that as a result of decreasing rodent numbers, kestrels relied preyed more heavily on lizards (Putman 1986). Inside the Seashore, decreases in predation by raptors and owls on lizards, frogs and snakes is likely to occur in areas of decreased non-native deer density.

Impacts to amphibians and reptiles in PRNS with Alternative D are expected to be beneficial to a moderate number of species. The impacts are moderate and long-term.

Cumulative Impacts

During the period when non-native deer are still present at PRNS, their cumulative impacts along with those from other factors affecting wildlife would be similar to those described for Alternative A. These include agricultural impacts to biodiversity, development and loss of habitat, loss of acorns as a food supply from a combination of increases in other non-native wildlife (turkeys) and sudden oak death. When non-native deer are eradicated, the beneficial cumulative (e.g., combined or additive) impacts of their disappearance to native wildlife will result, although continued adverse impacts would persist from continued ranching.

Conclusion

This alternative would result in a marked decrease in total non-native deer numbers and range over current levels over the next 15 years in the Seashore. No impairment to native wildlife would occur from implementing Alternative D. Based on research on impacts of non-native deer to wildlife in other countries as well as known impacts of grazing by cattle and white-tailed deer in the U.S., the impacts of Alternative D are expected to be beneficial, within NPS boundaries, to a large number of native species and adverse to a much smaller number of native species. Because the Vedanta property is surrounded by NPS lands but outside of NPS management authority, it is likely that deer densities there would increase initially, as a result of lethal removals in the Seashore. Short-term, native species richness and diversity would likely decrease in those high-density areas. Overall and in the long-term, the magnitude of impacts to native wildlife within and outside of NPS boundaries are considered moderate to major in intensity, depending on the species, and beneficial. Cumulative impacts of Alternative D, because they are considered incrementally with projects that have both adverse and beneficial long-term impacts to wildlife, are considered mixed.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Moderate to major
Cumulative Impacts:	Minor to moderate adverse in the short term; beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Species and Habitats of Management Concern

This category includes federally listed wildlife species, as well as other species of concern. Those recognized by the state of California or Birds of Conservation Concern (USFWS) include several species of nesting land birds and raptors.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect federally and state listed species, anecdotal and historical evidence and expert opinion can provide insights and guidance. The federally listed species that are likely to be affected by non-native deer include northern spotted owls (*Strix occidentalis caurina*), western snowy plover (*Charadrius alexandrinus nivosus*), California red-legged frog (*Rana aurora draytonii*), Coho and Chinook salmon (*Oncorhynchus kisutch and tshawytscha*), steelhead trout (*Oncorynchus mykiss*), and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

Analysis

Special Status Species

Northern Spotted Owl

The northern spotted owl is a federally threatened species that reaches the southern limit of its range within GGNRA, PRNS and Muir Woods National Monument in Marin County, California. Data collected by the NPS indicates that these parks may support the highest density of spotted owls known. However, the population is geographically isolated and subject to unique threats including urban development, intense recreational pressure, habituation of owls to humans, potential for catastrophic wildfires, and changes in hazardous fuel management practices. Owls occur throughout the forested lands in the Seashore and the population is likely stable; however, owls have been monitored for only 7 years in the Seashore (NPS and PRBO unpublished data). Owls prey almost exclusively on small mammals, particularly dusky-footed wood rats (*Neotoma fuscipes*) in the Seashore (Chow 1998). Woodrats, in turn, are dependent on roots, stems, leaves, seeds and mast (Linsdale and Tevis 1951; Willy 1992).

Fallow deer have been recorded in areas where spotted owls nest and roost. To date, no direct effects have been noted on the productivity or survival of owls. However, deer compete with the prey species of owls, and therefore, likely have an indirect negative impact on food resources. By biting off buds and flowers they reduce the amount of seed and fruit available in autumn and winter. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996; Jurek 1977). In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls and kestrels, especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely beneficial impact on rodent prey base due to reduced competition for food and cover, Alternative D would have a beneficial impact on northern spotted owls. Overall, the beneficial impacts of Alternative D to owls in the Seashore and in Marin County would be minor and long-term.

Western Snowy Plover

Western snowy plovers, federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS), nest along the sandy beaches of the Seashore, primarily on Point Reyes Beach between North Beach and Kehoe Beach. Historically, plovers also nested at South Beach, Drakes Beach and Limantour. Plover nesting success has increased slightly over the past few years due to intensive management by the Seashore; however, the species is vulnerable to numerous activities in the park including predation by

ravens and disturbance by recreationists. Fewer than 20 chicks fledged in 2002 (Peterlein 2002). Cattle roaming on the beaches in the past were a potential source for disturbance; however, the Seashore now intensively restricts cattle from beaches. A large herd of 60 axis deer has been seen on South Beach within the last five years, and where the herd occurred, the ground was heavily impacted (S. Allen, NPS personal communication). The frequency of this activity by axis deer is unknown but likely does not occur with regularly. Consequently, the overall beneficial impact of Alternative D to plovers in the Seashore is likely minor.

California Red-legged Frog

The California red-legged frog was federally listed as a Threatened species on June 24, 1996. Red-legged frogs breed in ponds or pools during the wet season (December through March), and use ponds and/or riparian habitats during the rest of the year. Currently, fallow deer regularly frequent riparian areas, girdle small trees and vigorously rub and thrash their antlers during the rut, resulting in maiming and destruction of riparian vegetation. While engaged in this activity, fallow deer cause extensive trailing and may trample frogs. Damage to the vegetation may be degrading non-breeding frog habitat. Overall, the beneficial impacts of Alternative D to frogs in the Seashore would be minor and long-term.

Coho Salmon, Steelhead Trout, and Chinook Salmon

As noted elsewhere in this EIS, these three species of threatened or endangered anadromous fish occur in many of the streams of the Seashore, particularly in Olema Creek and Lagunitas Creek. The Seashore contains 10% of the last remaining wild population of Coho salmon within the Central California Coast Evolutionarily Significant Unit, and consequently, any loss of this population would have an impact on the evolutionary significant unit. The NPS, along with the NOAA Fisheries and the CDFG, have conducted intensive fish surveys and have funded and implemented numerous restoration projects along the streams that flow through the park and adjacent lands. Numerous culverts have been removed along with other blockages to fish passage. In addition, the agencies have installed fencing to restrict cattle from riparian areas. These fences, though, do not impede the movement of fallow deer.

Currently, fallow deer regularly frequent riparian areas and damage riparian vegetation, particularly during the rut when deer girdle trees, thrash branches and leaves with their antlers. While engaged in this activity, fallow deer may indirectly affect the fish by damaging riparian plants, resulting in: increased erosion and sediment delivery to the stream, reduced cover, and potentially warmer water in streams due to exposure to sunlight. Eradicating fallow deer would remove this impact to riparian vegetation. In addition, removing non-native deer would improve the success and effectiveness of riparian restoration projects for salmon. In restoration areas, revegetation efforts and natural regrowth would no longer be retarded due to heavy grazing and antler rubbing. This alternative reduces the risk of fish redds being trampled in riparian areas where large numbers of fallow deer currently congregate or travel. Overall, the beneficial impacts of Alternative D to anadromous fish in the Seashore would be minor and long-term.

California Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is listed by the USFWS as endangered. The shrimp inhabits lower Lagunitas Creek and lower Olema Creek, within the current fallow deer range at PRNS. Shrimp are highly dependent on overhanging riparian vegetation, under which they live year-round. Fallow deer have not been observed within known shrimp habitat. However, in other areas of both Lagunitas and Olema Creeks, high densities of fallow deer have been observed to cause wide, straight trails, girdle trees, browse and trample riparian vegetation (Fellers and Osbourn 2006; Brannon Ketcham,

NPS, personal communication). A decrease in fallow deer range resulting from Alternative D is not likely to cause either adverse or beneficial impacts to shrimp habitat or shrimp survival.

Myrtle's Silverspot Butterfly

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) is one of three coastal subspecies of *S. zerene* in the Western United States. The USFWS listed the subspecies as endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992).

As of 1998, three populations are known to remain. The USFWS Myrtle's Silverspot Butterfly Recovery Plan (1998) estimated the three populations combined comprise 10,000 individuals. Two populations of Myrtle's silverspot butterfly occur within the Seashore and the third is on private land in northern Marin County. The Center for Conservation Biology at Stanford monitored distribution and abundance of the Myrtle's silverspot butterfly at Point Reyes National Seashore almost yearly from 1992 to 1998. The Stanford survey work shows a decline in Myrtle's silverspot butterfly population levels during the six-year period and the central population to be "barely existing" (Launer et al. 1998). Grazing is believed to deplete the Myrtle's silverspot butterfly larval host plants. The Seashore is currently supporting an intensive survey of the habitat of the Myrtle's silverspot butterfly and research on the current abundance and distribution of the larval host plant and adult nectar sources.

The PRNS coastal dune system and coastal prairie provide critical habitat for the Myrtle's silverspot butterfly. Many different plants are used by the Myrtle's silverspot butterfly's as nectar sources; native plants (*Grindelia rubicaulis, Abronia latifolia, Monardella undulata, Erigeron glaucus,* and *Wyethia sp*.) as well as non-native bull thistle (*Cirsium vulgare*) and Italian thistle (*Carduus pycnocephalu*s). The only known larval host plant is the western dog violet (*Viola adunca*).

Axis and fallow deer frequent coastal prairie habitat. To date, it is not known whether they browse on the preferred nectar or larval host plants of the Myrtle's silverspot butterfly. Research in which deer-proof exclosures were monitored in the New Forest in England showed that fallow deer preferentially consumed a *Viola* species in a 1969 but not in a repeat survey in 1978 (Putman 1986). In Hawaii, the introduction of axis deer and mouflon sheep to Lana`i have likely played a major role in the disappearance of *Viola lanaiensis* (USFWS 1995a). Another Hawaiian species, *Viola kauaensis* var. *wahiawahensis,* is also listed as endangered by USFWS because of perceived threats of habitat degradation by feral animals and axis deer (USFWS 1995b). It therefore is likely that non-native deer, given the opportunity, currently graze on the Myrtle's silverspot butterfly's larval host plant.

Decreased grazing would increase availability of these plants for the butterfly. If the fallow and axis deer populations were eradicated, adverse impacts to the vegetation used by this butterfly would likely decrease. Overall, the impacts of Alternative D to Myrtle's silverspot butterfly in the Seashore would be beneficial, moderate to major and long-term.

Bird Species of Concern

The Seashore has collaborated with the Point Reyes Bird Observatory over the past two decades to protect and restore habitat of nesting land birds within the boundaries of the Seashore. Many species of land birds are species of concern both under the California Bird Species of Special Concern (CDFG) and the Birds of Conservation Concern (USFWS). Examples of species include common yellowthroat *(Geothlypis trichas sinuosa*), California Swainson's thrush *(Catharus ustulatus oedicus),* and tricolored blackbird *(Agelaius tricolor).*

Numerous restoration projects and fire management actions have strived to improve nesting success in land birds, particularly in riparian areas. In addition, the park is an active member of the Partner-in-Flight program, collaborating with other agencies and organizations to protect and restore populations of neotropical migratory songbirds. The Point Reyes Bird Observatory has monitored the reproductive success and species composition of birds for more than 30 years. Monitoring has taken place in areas of the park (Palo Marin) where fallow deer occur only rarely.

In areas where fallow deer are currently abundant, there often is a well-defined browse line on trees and shrubs between 1.5 and 2 meters above the ground. Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests have suggested that some bird species, namely understory nesters, declined with high deer grazing pressure (Fuller 2001). Similarly, ground or low nesting (approximately 0.0–3 meters) bird species found in the Seashore are presently vulnerable to heavy grazing by non-native deer. These species are found in habitats where the greatest impacts from large herds of non-native deer are occurring (T. Gardali, Point Reyes Bird Observatory, personal communication; Shuford and Gardali, in review). Current non-native deer numbers may be limiting nesting species that depend on understory vegetation to place their nests. Current impacts on reproductive success and survival are unknown. Overall, the adverse impacts of Alternative D to understory nesting songbirds of concern in the Seashore and in Marin County are likely to be beneficial, moderate to major and long-term.

Plant Species of Special Concern

This category includes federal, state, and California Native Plant Society listed plant species.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect plant species of special concern, anecdotal and historical evidence and expert opinion can provide insights and guidance. Rare plants have been inventoried at Point Reyes National Seashore over the past twenty years. The preponderance of this information is presence/absence data for species of concern, with some additional data describing distribution of select species. Given the substantial amount of plant distribution data, it is important to note that this information only describes known rare plant occurrences. Obviously there are many acres within the Seashore that have not yet been surveyed for rare plants. Impacts related to rare plants, therefore, can only be estimated in terms of limited best available information.
Rare plants known to occur within current axis deer range include:

- *Arabis blepharophylla*, coast rock cress
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Cordylanthus maritimus ssp. palustris*, Point Reyes bird's beak *
- *Fritillaria liliaceae*, fragrant fritillary**
- *Grindelia hirsutula* var*. maritima* San Francisco Bay gumplant
- *Limnanthes douglasii* var. *sulphurea*, Point Reyes meadow foam*
- *Linanthus grandiflorus*, large-flowered linanthus
- *Triphysaria floribundus,* San Francisco owl's clover

Rare plants known to occur within current fallow deer range include:

- *Abronia umbellata ssp. breviflora*, pink sand-verbena
- *Agrostis blasdalei*, Blasdale's bent grass
- *Arabis blepharophylla*, coast rock cress
- *Arctostaphylos virgata*, Marin manzanita

- *Astragalus pycnostachyus var. pycnostachyus*, coastal marsh milk-vetch*
- *Calystegia purpurata* ssp. *saxicola*, coastal bluff morning-glory
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus var. gloriosus*, Point Reyes ceanothus
- *Ceanothus gloriosus var. porrectus*, Mt. Vision ceanothus
- *Chorizanthe cuspidata* var. *cuspidata*, San Francisco bay spineflower
- *Cordylanthus maritimus ssp. palustris*, Point Reyes bird's beak *
- *Elymus californicus*, California bottlebrush grass
- *Fritillaria affinis var. tristulis*, Marin checkerlily**
- *Fritillaria liliaceae*, fragrant fritillary
- *Gilia capitata ssp. chamissonis*, dune gilia
- *Grindelia hirsutula* var. *maritima* San Francisco Bay gumplant
- *Lilium maritimum*, coast lily**
- *Linanthus grandiflorus* large-flowered linanthus
- *Microseris paludosa*, marsh microseris*
- *Perideridia gairdneri ssp. gairdneri*, Gairdner's yampah
- *Polygonum marinense*, Marin knotweed
- *Ranunculus lobbii*, Lobb's aquatic buttercup*
- *Sidalcea calycosa ssp. rhizomata*, Point Reyes checkerbloom*
- *Triphysaria floribundus*, San Francisco owl's clover

* These species occur in wetlands or saltmarsh habitats. It is highly unlikely that these species are affected by non-native deer activities.

** Denotes bulb species.

Non-native deer can impact rare plant species directly by consuming and trampling them. PRNS staff observed fallow deer digging up and eating *Fritillaria* bulbs within the burned area after the 1995 Vision Fire (Sarah Allen, NPS, personal communication). It should be noted that damage to *Fritillaria sp.* and other lily species has been observed outside exotic deer range, presumably caused by black-tailed deer or other herbivores (Michelle Coppoletta, NPS, personal communication). Based on analyses of deer diets conducted in Point Reyes, it can be inferred that after a major vegetation-changing event such as a wildfire, both axis and fallow deer would seek other food sources to supplement a depleted diet (Elliott 1983). This might include heavier foraging on bulb species.

Other plant species that may be currently impacted by non-native deer are those occurring in areas of high deer densities, where damage to plants is through trampling. Fallow deer herds have been observed most often in grassland, evergreen scrub, and Douglas fir/redwood plant communities (NPS 2001b). These communities provide habitat for the plant species listed above. Adverse impacts to rare plants in the Seashore are currently considered to be minor and short-term. Alternative D would result in beneficial impacts to rare plants, which are minor and long-term.

There are no means of mitigating the impacts of non-native grazing herbivores to the species of special concern of the Seashore.

Cumulative Impacts

In the long term following removal of non-native deer, beneficial cumulative impacts to species of management concern would occur from above described restoration projects. However, during the

removal process, adverse cumulative impacts of Alternative D would be similar to those described for Alternative A. These result from incremental adverse effects of Alternative D and development, visitor use, habitat change and wildfires for most species analyzed. In addition, spotted owls are affected by a reduced availability of the prey species, dusky footed woodrats, which feed on acorns. Red-legged frogs may be additionally adversely affected by the restoration of the Giacomini wetlands to coastal, rather than freshwater, habitat. Restoration of riparian habitat inside the park would offer beneficial cumulative impacts to red legged frogs, as well as to listed anadromous fish species. The Giacomini restoration would have beneficial cumulative effects on these fish species as well. Ongoing ranching operations can increase sedimentation and change nutrient concentrations in water and soil, with potential adverse cumulative effects on riparian or water-dependent species of special concern (red-legged frogs, freshwater shrimp, anadromous fish) and on the host plant for Myrtle's Silverspot Butterfly.

Conclusion

No impairment to special status species would occur from implementing Alternative D. All of the impacts associated with the eradication of non-native deer are characterized as beneficial to plant and animal species of concern. Depending on the special status species in question, the impacts of Alternative D range from minor to moderate and are long-term. Cumulative impacts of Alternative D, because they are considered incrementally with projects that have both adverse and beneficial long-term impacts to special status species, are considered mixed.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Mixed—minor to moderate
Cumulative Impacts:	Minor to moderate adverse in the short term; moderate to major beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Human Health and Safety

Analysis

Under this alternative, all non-native deer would be removed from the Seashore within a 15-year period through the use of firearms by NPS staff. With adherence to applicable regulations and policies the potential risk to human health and safety would be kept to minor, adverse impacts. Because impacts of individual treatment efforts are transitory, they are characterized as short-term, while additional long-term impacts are expected as a result of the 15-year period of eradication efforts.

Under this alternative, the numbers and range of both species of non-native deer are expected to decrease to zero in 15 years. A concomitant decrease in deer-vehicle collisions over current levels is expected, a minor to moderate, long-term benefit to human safety related to the reduction risk of deer-vehicle collisions, an effect similar to that expected under Alternative E.

Cumulative Impacts

Alternative D does not measurably add to the impacts on health and safety of the projects or issues listed in Alternative A.

Conclusion

The risk of firearms-related injury is increased under this alternative when compared to existing conditions, a minor, adverse impact to human safety, of short- and long-term duration. Minor to moderate benefits to public health and safety resulting from reduced risk of deer-vehicle collisions are expected. When compared to No Action, this alternative poses a higher potential level of risk to human safety related to the use of firearms. At the same time, when compared to No Action, risks to human safety are slightly reduced under this alternative related to the potential decrease in deer-vehicle collisions.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor to moderate
Cumulative Impact:	Long-term beneficial and adverse minor to moderate

Impacts on Visitor Experience

Analysis

The 15-year goal of this alternative is the eradication of all non-native deer within the Seashore, resulting in minor, long-term, adverse effects to wildlife viewing opportunities, particularly for those interested in fallow deer. However, under this alternative the native black-tailed deer may increase in numbers as they move into areas previously occupied by non-native deer. This would represent a minor to moderate, long-term benefit to the related visitor experience. If this should occur, the effects on overall wildlife (deer) viewing opportunities would be negligible.

Effects on the visitor experiences related to viewshed enjoyment under this alternative are similar to those described under Alternative B (negligible).

Visitor experience also relates to social values, particularly those of attitudes towards animals. Effects of the management technique proposed under this alternative (lethal removal/firearms) could result in adverse effects to visitors, particularly those with humanistic and moralistic values, to varying degrees and for varying periods of time. These effects are similar to those described under Alternative B (negligible to moderate, short-term, adverse—depending on the visitor and his/her level of objection to the use of the proposed method). Mitigation measures for this alternative are similar to that described under Alternative B.

Wilderness Character

The current degraded conditions in the wilderness would improve most quickly in this alternative and in Alternative E. As non-native deer were removed, during a 15-year time period, the wilderness character would appear unnatural. Visitors to the wilderness would occasionally encounter NPS staff or contractors. During times of deer management, noise of firearms would mar the natural quiet backcountry users often seek. Few users would be directly affected by noise, as all alternatives call for shooting to take place outside of peak visitation hours. Temporary area closures for large-scale deer management activities are a possibility with this alternative and could inconvenience some visitors. In addition, a small number of visitors could discover carcasses in the wilderness areas where retrieval by NPS staff or contractors is not possible. Moving any carcass near a heavily used trail to a more remote location to reduce odor problems or conflicts between humans and scavengers would mitigate this impact. The impacts of firearms and helicopter use related to the soundscape and wilderness values, the potential temporary closures of deer

management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in short-term, negligible to moderate, adverse impacts – depending on the numbers of visitors affected and their particular experience (e.g., distance from impact, level of recreational disruption, duration of each management incident, etc.). Based on what is known of visitor use patterns in Seashore wilderness areas, these adverse impacts are estimated to affect fewer than 50 visitors per year. Such impacts would be totally eliminated within 15 years.

The direct temporary adverse impacts to the wilderness experience would be outweighed by the beneficial long-term effects of increased protection of wilderness habitat. With the riparian and woodland impacts of non-native deer eliminated and native deer restored to natural numbers, the landscape would return to a more natural state, both ecologically and in the eyes of some visitors. This would preserve integral components of wilderness character including the restoration of natural processes and the eventual reduction in signs of external human influence.

Wilderness Values

In the long term, restoring natural ecological processes Seashore wilderness would have long-term beneficial impacts to those people with biocentric values and short-term adverse impacts for those with symbolic or aesthetic values. The former group is characterized by people who most appreciate natural or ecological conditions in wilderness and so restoring these conditions would have permanent and positive effects on their social values regarding wilderness. Intrinsic or symbolic values include aesthetic and spiritual values, and this group might describe wilderness as similar to a church, e.g. as offering a transcendental experience or a part of the earth where humans should be humbled by forces larger than themselves and restrain any effort to manipulate.

Cumulative Impacts

Cumulative impacts under Alternative D are similar to those described for Alternative B.

Conclusion

This alternative results in complete removal of non-native deer from the Seashore by 2021. Adverse impacts to the visitor experience are related to wildlife viewing (minor, long-term); social values (negligible to moderate, short-term); symbolic or aesthetic wilderness values (minor, short-term) and soundscape/access/visual intrusions (negligible to moderate, short-term). Long-term minor to moderate benefits to visitor experience related to viewing of native deer and to those with biocentric wilderness values are also expected under this alternative. Compared to the No Action alternative, Alternative D would result in increased benefits to wilderness character and to viewing of native deer, with increased adverse impacts related to viewing of non-native deer, social values, and soundscape/access/visual intrusions. Short-term cumulative impacts under Alternative D, as in Alternative B, would be minor and adverse while long-term cumulative impacts would be major and beneficial.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Negligible to moderate
Cumulative Impacts:	Minor adverse in the short term; major beneficial in the long term

Impacts on Park Operations

Analysis

Removal of all non-native deer within the Seashore under this alternative would result in the elimination of associated resource and operational impacts by 2021. Operational costs would increase substantially from 2005 to 2018 due to personnel, material, services and administrative costs of the removal program. Over time, as population numbers decline, per-unit costs could be expected to increase based upon an increasing level of effort to find remaining animals, but overall costs for the program would diminish. Similarly, other costs of mitigating adverse impacts of non-native deer to natural resources would decline as axis and fallow population sizes diminish.

The types of actions associated with the monitoring of non-native deer and the mitigation of damage to natural resources by deer under Alternative D are initially similar to those described under Alternative B. However, impacts (and associated expenses) under Alternative D would be completely eliminated with the removal of all non-native deer populations by 2021, while impacts under Alternative B would continue indefinitely.

Chapter 2 outlines the likely deer removal numbers required in Alternative D, based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, this alternative would require culling of up to 200 non-native deer per year (approximately 150 fallow deer and approximately 50 axis deer) to remove all non-native deer by the year 2021. It should be noted that these numbers are subject to change depending on precipitation, range conditions and herd growth parameters. Cited figures should be considered approximate guidelines for cost analysis purposes.

The costs of culling of approximately 200 deer yearly includes staff (including one full-time biotechnician), training, vehicles, transport, supplies and carcass disposal and are estimated to be $115,000 per year. During the eradication program, estimated to last from 2006 to 2021, costs of controlling non-native deer constitute a 132% increase in funds allocated to non-native deer. See Figure 17 for a comparison of the costs of the alternatives considered.

Estimates of minimum cost of implementation of Alternative D total approximately $3.8 million by the year 2021. Thereafter, as a result of non-native deer eradication, no costs are expected. The costs of implementing Alternative D, an increase of 4.5% in the total PRNS annual budget, can be expected to decrease to zero in the future.

Under Alternative D, non-native deer monitoring, natural resource mitigation and elimination (lethal removal) of all deer by 2021 could result in minor, short-term, adverse impacts to park operations. Such impacts result from the increased budgetary expenditures required for implementation. Conversely, moderate, long-term benefits to park operations are expected as all non-native deer management costs decrease and are eventually eliminated within PRNS.

Cumulative Impacts

Cumulative impacts for Alternative D are similar to those described for the No Action Alternative (adverse and moderate) but are short-term rather than long-term because they do not persist indefinitely.

Conclusion

Adverse impacts to park operations under Alternative D associated with eradication of non-native deer populations would be minor and short-term. This is because additions in cost and/or energy usage would represent an approximately budgetary increase of 4.6% of the total park budget and would last only until all actions are completed (by 2021). Beneficial, long-term impacts to park operations under this alternative are characterized as moderate as costs associated with non-native deer management would eventually decrease to zero permanently. When compared to the No Action alternative and its projected budgetary increase (5–15%, in perpetuity), Alternative D offers a notably reduced budgetary commitment (4.5% increase), a benefit to park operations. Alternative D is the least expensive of any of the alternatives. Cumulative impacts for Alternative D are adverse, short term and moderate.

Type of Impact:	Mixed—adverse in the short-term, beneficial in the long-term
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor
Cumulative Impacts:	Moderate short term adverse

Impacts on the Regional Economy

Analysis

Non-native deer have no documented measurable beneficial impacts to the regional economy. Currently there are an estimated 250 axis deer and approximately 860 fallow deer in the Seashore. This alternative would decrease, and eventually eliminate all non-native deer and their associated impacts to the local economy. Current impacts to those permittees who see non-native deer year-round include (refer to the Regional Economy section of Chapter 3, Affected Environment):

- Fence repair costs ($500-$1000/yr per ranch [4 reports])—damage by deer crossing.
- Costs of lost pasture forage (unknown costs [4 reports])—pasture forage consumption by non-native deer.
- Costs of lost supplemental feed (unknown costs [1 report])—supplemental food put out for livestock eaten by non-native deer.
- Costs of reseeding pastures ($9000/yr rancher [1 report])—overgrazing of fallow fields by non-native deer.
- Veterinary costs ($1200 in 2001 [1 report])—leptospirosis.

Although it is likely that native black-tailed deer numbers would increase as a result of decreased competition for forage, black-tailed deer are primarily browsers and not likely to significantly impact livestock pastures, reseeded fields or supplemented hay. In addition, black-tailed deer do not congregate and travel in large herds as do axis and fallow deer, and rarely cause fence damage. Although black-tailed deer do carry diseases of concern to ranchers, the risks of transmission from small, dispersed groups of native deer are less than those from the large groups of non-native deer which can be found close to stock ponds, ranch horses and cows. Even with an increase in black-tailed deer numbers as a result of non-native deer removal, costs of fence damage and other deer depredation to ranchers would decrease significantly over current levels. Impacts of fallow deer to agricultural operations outside of NPS boundaries but within Olema Valley are also expected to decrease with this alternative. The eventual elimination of the non-native deer populations within the park and their associated adverse impacts to agricultural concerns would result in a minor, long-term benefit to the regional economy.

This alternative would not have significant and disproportionate effects on minority and low-income populations.

Because this alternative might require occasional area closures but no park closures, there are no expected effects on local tourist businesses.

Cumulative Impacts

Alternative D does not measurably add to the impacts on the regional economy of the projects or issues listed in Alternative A.

Conclusion

This alternative would result in removal of all fallow deer and axis deer within the Seashore and a prevention of their spread throughout Marin County. The action would result in minor benefits to agriculture and the regional economy within and outside of NPS boundaries. Because this alternative results in permanent removal of all non-native deer, the beneficial impacts to the local economy are long-term. Comparatively, the No Action alternative would likely result in the greatest number of adverse effects to the regional economy by way of agricultural impacts and potential impacts to low-income farm workers.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term, major and beneficial

Environmental Consequences of Alternative E (Preferred Alternative): Removal of all Non-Native Deer by a Combination of Agency Removal and Fertility Control

This alternative would remove all fallow and axis deer from PRNS and PRNS–administered lands in 15 years, through a combination of lethal and non-lethal techniques. Until contraceptive technology advanced, only fallow does would be treated with contraceptives while both fallow and axis deer would be lethally removed. If a promising long-duration agent for axis deer were developed, it would be used experimentally. It is expected that large numbers of deer would be lethally removed in the first 5 years of the program and that because of increased wariness on the part of the deer and lower deer densities, a more gradual decrease over the next 10 years would follow. Similarly, most of the treatment of does with contraceptives would occur in the first 5 years of the program, in order to decrease recruitment of fawns and thereby reduce the total number of animals culled. Because contracepted animals would not be removed from the park, it is expected that deer numbers would not decrease as rapidly with this alternative as with Alternative D (Removal of All Non-Native Deer by Agency Shooting), thus prolonging adverse impacts to natural resources. However, the most serious impacts, that is, in areas of high deer density, would be carefully monitored (See monitoring and management plan, Appendix C) and using an adaptive management approach, mitigated with lethal removal. An effort would be made to remove or treat deer in a manner that did not lead to increased migration outside of NPS boundaries and it is expected that this alternative would not result in increased numbers of non-native deer on adjacent state park or private lands. However the Vedanta property, which currently contains the highest fallow deer densities in Olema Valley (up to 80 deer/ sq. km.), is outside of NPS management jurisdiction and surrounded entirely by NPS lands. It is likely that during the lethal removal program in the Seashore, deer densities on this inholding would increase temporarily.

The impacts to natural resources and the regional economy do not differ between Alternative D and E. Impacts of Alternative E to park operations, health and human safety and visitor experience differ slightly from those of Alternative D.

Impacts on Water Resources and Water Quality

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative D. The impacts of non-native deer elimination in 15 years would constitute an alleviation of current impacts to water resources and water quality.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Mixed—both short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Moderate
Cumulative Impacts:	Minor to moderate adverse in the short term; beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Soils

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative D. Non-native deer elimination in 15 years would constitute an alleviation of current impacts to soil.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor adverse and moderate beneficial
Cumulative Impacts:	Minor to moderate adverse in the short term; beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Vegetation

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative D. Potential consequences of non-native deer eradication are lower concentrations of animals within a variety of plant communities. Alternative E would alleviate current impacts to vegetation including direct effects of deer foraging, trailing, congregating, thrashing and girdling.

Type of Impact:	Mixed—both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor adverse and moderate to major beneficial
Cumulative Impacts:	Minor to moderate adverse in the short term; long-term, moderate to major, beneficial and moderate adverse cumulative impacts (after non-native deer are eradicated)

Impacts on Wildlife

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, to native species are not different from Alternative D. In general, eventual disappearance of non-native deer would have beneficial impacts to other native wildlife species in the Seashore.

Although fewer non-native deer would be lethally removed in Alternative E than in Alternative D, pain and suffering would result from lethal removals as well as from fertility control. Some of this pain would be mitigated by use of trained sharpshooters in culling deer. Efforts would be made to deliver immediately lethal shots to target animals and sharpshooters would be required to complete NPS range qualifications specifically designed for ensuring humane and effective wildlife removal. Animals treated with contraceptive agents would undergo the stress of capture, restraint, injection and permanent marking (i.e., radio-collaring and ear-tagging) at least once during their lifetimes. Capture of deer would result in unavoidable injuries and some deaths.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Moderate to major
Cumulative Impacts:	Minor to moderate adverse in the short term; beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Species and Habitats of Management Concern

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative D. All of the impacts associated with the elimination of non-native deer are characterized as beneficial to plant and animal species of concern.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Mixed—minor to moderate
Cumulative Impacts:	Minor to moderate adverse in the short term; moderate to major beneficial and adverse cumulative impacts in the long term (after non-native deer are eradicated)

Impacts on Human Health and Safety

Analysis

Under this alternative, it is assumed that approximately 75% of fallow and 100% of axis deer would be removed over a 15-year period through the use of firearms by NPS staff or contractors, posing risks of firearms-related injury to staff and visitors. With adherence to appropriate regulations and policies, these risks would be minimized and would keep impacts to human safety at minor levels.

Depending on the agent used, Alternative E calls for treatment of up to 25% of fallow does with a long-acting contraceptive or sterilant. In order to evaluate the effectiveness of any experimental treatment and to avoid inadvertently culling treated animals, NPS would have to capture and immobilize animals for permanent marking (ear-tagging and radio-collaring). Permanent marking of treated animals would be needed to ensure accurate monitoring of contraceptive effectiveness and to prevent inadvertent culling of treated does. Capture would be accomplished with a corral trap, Clover trap, a drop net, or with a net gun fired from a helicopter. Regardless of the technique used, wildlife capture, and immobilization could result in injury to participating staff, either from the animals themselves or from equipment and aircraft. The number of people at risk of treatment-related injury under Alternative E could range from 20-50 per effort, depending on the capture/treatment techniques used over a period of 15 years. Adverse impacts to human safety of minor intensity would be likely. Impacts could be expected to be both short-term (transitory, individual capture/treatment incidences) and long-term (15-year period) in duration.

The effect on human health and safety related to non-native deer population reduction efforts and deer-vehicle collisions under this alternative are similar to that expected under Alternative D (long-term, minor to moderate benefits).

Cumulative Impacts

Alternative E would not change the potential intensity or duration of the impacts to human health and safety resulting from the cumulative impacts of all the projects listed in Appendix F. There are no known incremental cumulative impacts associated with Alternative E.

Conclusion

The risk of injury related to firearms and contraceptive treatments is increased under Alternative E when compared to existing conditions; a minor, adverse impact to human health and safety of short- and long-term duration. Minor benefits to human safety could be realized as a result of likely reductions in numbers of deer-vehicle collisions under this alternative. When compared to No Action, Alternative E would result in increased risks to human safety as a result contraceptive treatments and the use of firearms. Conversely, when compared to No Action, Alternative E offers slight benefits related to potentially decreased deer-vehicle collisions.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor
Cumulative Impact:	Long-term beneficial and adverse minor to moderate

Impacts on Visitor Experience

Analysis

Under this alterative, effects on wildlife viewing, particularly non-native and native deer species, are similar to those described under Alternative D (viewing of non-native deer—minor, long-term, adverse; viewing of native deer—minor to moderate, long term benefits).

Effects on the viewshed related to the visitor experience under this alternative are similar to those described under Alternative B (negligible).

Under this alternative, visitor experience is also related to social values, particularly those of attitudes towards animals. Effects of the management techniques proposed under this alternative (lethal removal and contraceptive methods) could result in adverse effects to the visitor experience to varying degrees and for varying periods of time. These effects are similar to those described under Alternative B (negligible to moderate, short-term, adverse—depending on the visitor and his/her level of objection to proposed methods). As proposed under Alternative E, if contraception proves effective in aiding the elimination of deer populations, this alternative would represent a less lethal management approach than that proposed under Alternative D (lethal removal only). This less lethal approach has the potential to benefit or adversely affect visitor experience, depending on individual social values. Mitigation measures under this alternative are also similar to that described under Alternative B.

Wilderness Character and Values

Impacts of Alternative E to wilderness character and values would not be substantially different from Alternative D. Alternative E proposes the management of non-native deer through a combination of lethal controls and contraceptive methods to eliminate non-native deer populations over a 15-year period (Alternative D proposes only the use of lethal methods, that is, firearms, to accomplish the same goal). While the degree and type of effect differs slightly, impacts of firearms and helicopter use related to the soundscape and wilderness values, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in effects similar to that described under Alternative D (short-term, negligible to moderate, adverse impacts—depending on the numbers of visitor affected and the duration of each incident's effect). Based on what is known of visitor use patterns in Seashore wilderness areas, these adverse impacts are estimated to affect fewer than 50 visitors per year. Such impacts would be totally eliminated within 15 years. The direct temporary adverse

impacts to the wilderness experience would be outweighed by the beneficial long-term effects of increased protection of wilderness habitat necessary for the preservation of integral values of wilderness

Some visitors, especially those searching for a "wilderness experience" in the Seashore, might object to seeing permanent marks such as radio collars and eartags on experimentally treated does. Because the population control techniques in Alternative E would be used for a maximum of 15 years and are therefore transitory, impacts to visitor experience are characterized as short-term, minor, and adverse.

Cumulative Impacts

Cumulative impacts associated with Alternative E are similar to those described for Alternative B.

Conclusion

This alternative would result in the permanent removal of all fallow and axis deer within the Seashore within a 15-year period. Adverse impacts to the visitor experience are related to wildlife viewing (minor, long-term); social values (negligible to moderate, short-term); symbolic or aesthetic wilderness values (minor, short-term) and soundscape/access/visual intrusions (negligible to moderate, short-term). Long-term minor to moderate benefits to visitor experience related to viewing of native deer and to those with biocentric wilderness values are also expected under this alternative. Compared to the No Action alternative, Alternative D would result in increased benefits to wilderness character and to viewing of native deer, with increased adverse impacts related to viewing of non-native deer, social values, and soundscape/access/visual intrusions.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Negligible to moderate
Cumulative Impact:	Long-term beneficial and major

Impacts on Park Operations

Analysis

Removal of all non-native deer within the Seashore under this alternative would result in the elimination of associated resource and operational impacts of continued non-native deer management by 2021. Operational costs would increase substantially from 2006 to 2021 due to the personnel, material, services and administrative costs of the lethal removal and contraception programs. Over time, as population numbers decline, per-unit costs of lethal removal could be expected to increase based upon an increasing level of effort to find remaining animals, but overall costs for the program would diminish. Similarly, other costs of mitigating adverse impacts of non-native deer to natural resources would decline as axis and fallow population sizes diminish.

The types of actions associated with the monitoring of non-native deer and the mitigation of damage by non-native deer to natural resources under Alternative E are similar to those described under Alternative D.

Chapter 2 outlines the likely deer removal and treatment numbers required in Alternative E, based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, this alternative would require culling of up to 200 non-native deer per year (up to 150 fallow deer the first year with

decreasing numbers thereafter, and approximately 50 axis deer) to aid in the eradication of the population by the year 2021. It should be noted that these numbers are subject to change depending on precipitation, range conditions and herd growth parameters. If target cull numbers are a percentage of total doe numbers, they would decrease rapidly with time. Cited figures should be considered approximate guidelines for cost analysis purposes.

The costs of culling of approximately 200 deer in the first year includes staff (including one to two full-time biotechnicians), training, vehicles, transport, supplies and carcass disposal and are estimated to be $115,000 per year (similar to costs projected under Alternative D). Costs of removing fewer animals in later years would decrease, but cost of removal per animals would increase because of increased effort required to locate animals.

Because there is currently no long-duration contraceptive registered with the EPA for management of deer, any drug used by NPS would likely require experimental research. Costs of such research are difficult to predict but would exceed usual management costs. Research requires collection of data on survival and fawning rates of treated and control deer through radio telemetry, population counts and necropsies. Additional studies on health effects and safety of the experimental drug may be required by the EPA. The minimum costs of treating 100 does with a lifetime-effect contraceptive (if available) in year 1 of the program are estimated to be $210,000. Minimum costs of monitoring treated animals in future years would be approximately $45,000 per year for the next 6-12 years (the lifetime of treated animals). Should available contraceptives remain effective for less than the reproductive life of the does (less than 8–10 years), the cost of treating animals would be much higher.

During the culling and contraceptive programs, estimated to last from 2006 to 2021, costs constitute a 132% increase in funds allocated to non-native deer. See Figure 17 for a comparison of the costs of the alternatives considered.

Estimates of minimum cost for implementation of Alternative E total approximately $4.5 million by the year 2021; thereafter, as a result of the elimination of all non-native deer, no costs are expected. The costs of implementing Alternative E constitute an increase of 5% – 9% of the total PRNS annual budget, and can be expected to decrease to zero in the future.

Under Alternative E, non-native deer monitoring, natural resource mitigation, and lethal removal and contraception operations would result in short-term, moderate, adverse impacts to park operations as a result of increased (5–9%) budgetary expenditures. In addition, moderate, long-term benefits to park operations would be realized resulting from the eventual elimination of all non-native deer management activities.

Cumulative Impacts

Cumulative impacts for Alternative E are similar to those described for the No Action alternative (adverse and moderate), but would be short-term rather than in perpetuity.

Conclusion

In addition to cumulative impacts, adverse impacts to park operations associated with elimination of non-native deer populations under Alternative E are characterized as moderate and short-term due to a projected 5-9% increase in cost and/or energy usage of the existing park budget. These costs would be incurred until all actions are completed (2021). Beneficial impacts to park operations from this alternative are characterized as moderate and long-term due to the elimination of non-native deer management costs that would eventually decrease to zero. When compared to the No Action alternative and its projected

increase in budget commitments (5–15%, in perpetuity), smaller budgetary commitments under Alternative E (5–9%) would eventually be eliminated by the year 2021, constituting an overall positive effect on park operations. Cumulative impacts of Alternative E, with the actions listed in Alternative A, are characterized as short-term, adverse and moderate.

Type of Impact: Adverse and beneficial
Duration of Impact: Short-term (adverse) and long-term (beneficial)
Intensity of Impact: Moderate
Cumulative Impact: Short-term, adverse and moderate

Impacts on Regional Economy

Analysis and Cumulative Impacts

Impacts, including cumulative impacts, are not different from Alternative D. Impacts associated with the removal of all non-native deer within the park are characterized as beneficial to the regional economy

Type of Impact: Beneficial
Duration of Impact: Long-term
Intensity of Impact: Minor
Cumulative Impact: Long-term, major and beneficial

Unavoidable Adverse Impacts

The impacts identified below for each alternative are those that cannot be fully mitigated or fully avoided.

Alternative A: No Action

The No Action alternative, by definition, contains no measures to mitigate impacts to resources. Continued population growth and range expansion of non-native deer would result in unmitigated, severe, adverse impacts to soils, water resources, vegetation, wildlife, and special status species, both within and outside of NPS boundaries.

Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal

Within the Seashore and on the Vedanta Society property, there would be a continuation, albeit at lower levels, of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species.

Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control

Within the Seashore and on the Vedanta Society property, there would be a continuation, albeit at lower levels, of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species.

Alternative D: Removal of All Non-Native Deer by Agency Personnel

There would be a continuation of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species for the 15-year removal period. The intensity of these adverse impacts would decrease as the number of non-native deer in PRNS decreased.

Alternative E (Preferred Alternative): Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility control

There would be a continuation of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species for the 15-year removal period. The intensity of these adverse impacts would decrease as the number of non-native deer in PRNS decreased.

Relationship Between Local Short-Term Uses and Long-Term Productivity

Alternative A: No Action

Under the No Action alternative, increasing non-native deer numbers would degrade long-term natural productivity.

Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal

Reduction of total non-native deer numbers would enhance, to some degree, the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration, albeit incomplete, of overgrazed areas and, trampled riparian environments, and would reduce competition with native ungulates.

Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control

Reduction of total non-native deer numbers would enhance, to some degree, the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration, albeit incomplete, of overgrazed areas and trampled riparian environments, and would reduce competition with native ungulates.

Alternative D: Removal of All Non-Native Deer by Agency Personnel

Elimination of non-native deer would enhance the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration of overgrazed areas and trampled riparian environments, would reduce competition with native ungulates and eliminate impacts to other native species.

Alternative E (Preferred Alternative): Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility control

Elimination of non-native deer would enhance the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration of overgrazed areas and trampled riparian environments, would reduce competition with native ungulates and eliminate impacts to other native species.

Irreversible or Irretrievable Commitments of Resources

Irreversible commitments are those that cannot be reversed. Extinction of a species is an example of an irreversible loss. *Irretrievable* commitments are those that are lost and cannot be replaced. Deterioration past repair of a culturally significant building is an example of an irretrievable loss. The following section identifies irreversible or irretrievable commitments of resources resulting from the various alternatives.

Alternative A: No Action

Under the No Action alternative, loss of soil to erosion and potential extirpation of rare or special status species represent irreversible and irretrievable loss of resources.

Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal

Under this alternative, loss of soil to erosion and potential extirpation of rare or special status species represent irreversible and irretrievable loss of resources.

Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control

Under this alternative, loss of soil to erosion and potential extirpation of rare or special status species represent irreversible and irretrievable loss of resources.

Alternative D: Removal of All Non-Native Deer by Agency Personnel

Under this alternative, there would be no irreversible or irretrievable loss of resources due to identified actions.

Alternative E (Preferred Alternative): Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility control

Under this alternative, there would be no irreversible or irretrievable loss of resources due to identified actions.